SCIENTIFIC AMERICAN SUPPLEMENT. No 1020

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Scientific American Supplement, Vol. XL. No. 1020.
Scientific American, established 1845.

NEW YORK, JULY 20, 1895.

Scientific American Supplement, $5 a year.
Scientific American and Supplement, $7 a year.

OPENING OF THE NORTH SEA CANAL.

One of the most important engineering works of the nineteenth century was inaugurated June 20, when the Baltic and North Sea canal, which cuts across the base of the peninsula formed by Jutland and Schleswig-Holstein, was formally declared open to the commerce of the world.

Eight years have now passed since Emperor William I laid the foundation stone of the Holtenau lock, near Kiel, on June 3, 1887. His grandson opened the canal with imposing ceremonies. It was the occasion of a naval pageant which has never been equaled. From eighty to one hundred war vessels, representing the principal navies of the world, were present. Germany led with about forty vessels, then England with ten war ships, followed by Italy, Russia, the United States and Austria in order of their strength. The United States was represented by four ships, the Columbia, the New York, the Marblehead and the San Francisco. The United States fleet was under the command of Admiral Kirkland.

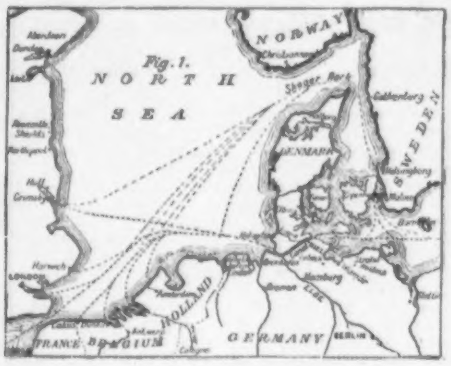
The Hamburg banquet was held on the evening of June 19. The international fleet passed through the canal from the western end on June 20. In the afternoon the Emperor gave a reception on board the royal yacht Hohenzollern. In the evening there was a grand ball at the naval academy at Kiel. On the 22d there was a naval parade followed by a grand banquet in the evening. The United States fleet was brilliantly illuminated by thousands of electric lights and special fireworks.

The completion of the canal is of far-reaching importance to Germany, Russia and Denmark. Thirty-five thousand vessels now annually pass around the peninsula, representing 20,000,000 tons. The chief value of the canal will consist in saving mariners from the perilous voyage around Denmark, whose rocky channels and reefs taken in connection with the storms and ice floes have been a constant source of danger for centuries. Nearly three thousand vessels have been wrecked and three thousand five hundred more seriously injured since 1858 off this wild coast. For large ships the coast is regarded as one of the most dangerous spots in Europe. The new waterway will permit vessels of ten thousand tons register to pass through. The canal is 61 miles long, 200 feet wide at the surface, and 85 feet wide at the bottom. The esti-

THE THREE GERMAN EMPERORS—GRAND MEDAL COMMEMORATING THE OPENING OF THE NORTH SEA CANAL.

mated cost is $39,400,000; of this sum, Prussia contributed $12,500,000. The work has been pushed with great energy. At times as many as eight thousand six hundred men were working at once. The strategic value of the canal to Germany cannot be overestimated, as her vessels will no longer have to pass through foreign waters. The city of Kiel will be of paramount importance in case of war, as it has a magnificent harbor and is already the most important naval station on the Baltic. The average time of transit through the canal will be 12 hours.

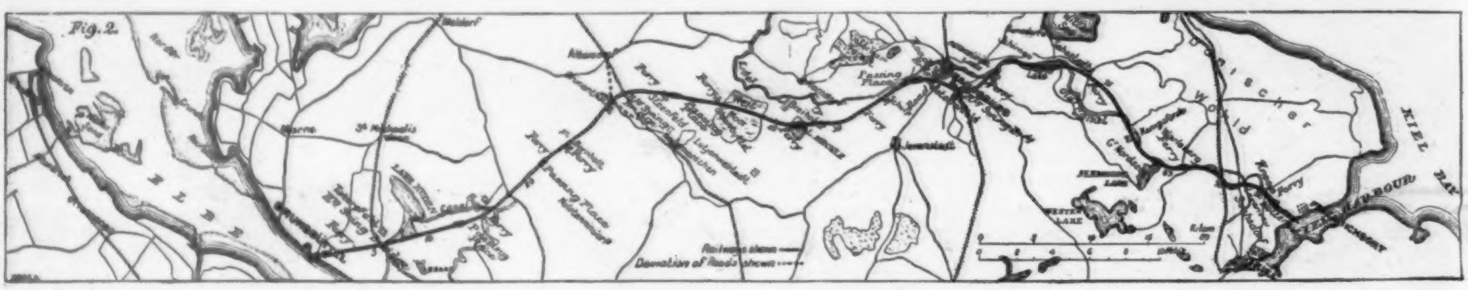
The maps we herewith present will convey an idea of the position and course of the new canal.



We give herewith several additional illustrations relating to the great canal. These engravings, for which we are indebted to our worthy contemporary, the Illustrirte Zeitung, include a portrait of Wirkl. Geh. Oberbaurath Otto Baensch, the designer and engineer of the canal. The knowledge and experience gained in his connection with bridge and other engineering work on the Elbe and the Rhine, and his thorough understanding of the requirements of iron structures, fitted him for this, the greatest work of his life. He, of course, made an exhaustive study of the coasts, and the tides and currents of the seas, and in fact devoted all his knowledge and his energies to the work which now does him such great honor. He has not only shown himself perfectly capable of carrying out such an enterprise, but in the meantime has won the love and respect of his co-workers and subordinates, as well as the esteem of the public.

Our other engravings show the large medal made to commemorate the completion of the canal, on which are the portraits of the three emperors; and the immense locks at Brunsbuttel and Holtenau. We have already published many details of the construction of these locks, the wonderful machinery used in building them, as well as on the other work of the canal, and of the bridges over the canal.

The idea of a canal across the peninsula is much older than many people suppose, for the first attempt to connect the North and Baltic Seas was made in 1389, when a short canal was built between the Stecknitz River, a tributary of the Trave, and the Delvenau, a tributary of the Elbe, thus making a complete waterway between the two seas. From that time to this sixteen different canals were projected, the sixteenth being the one just completed, which so overshadows all the others that it is no wonder they should be overlooked.



MAP OF THE NORTH SEA CANAL.

[Continued from SUPPLEMENT, No. 1019, page 16283.]

A LINE OF TWENTY-EIGHT INCH CAST-IRON SUBMERGED PIPES ACROSS THE WILLAMETTE RIVER, AT PORTLAND, ORE.*

By FRANKLIN RIFFLE and ALBERT S. RIFFLE, Ms. Am. Soc. C.E.

ABSTRACTS FROM THE DISCUSSION.

E. Kuichling, M. Am. Soc. C. E.—While the speaker had no experience with pipes of this kind under great internal pressures, yet he was familiar with a number of lines of flexible jointed pipe which were subjected to slight external pressures, such as intake pipes laid out from the shore into the deep water of rivers and lakes. A riveted steel pipe of this sort, 5 ft. in diameter and about 1,500 ft. long, was laid last fall under his direction in Hemlock Lake, Livingston County, N.Y., as the intake for supplying the new gravity conduit of the Rochester Water Works. The pipes were riveted together in lengths of about 100 ft., and provided at the ends with the component parts of ball and socket joints shown in Fig. 2. These flexible joints admit of a deflection of 17⅛° in any direction, and are made mostly of steel plates stiffened with bar, angle and channel rings, cast iron being used only for the spherical zones or ball portions. The latter were riveted with countersunk rivets to short sections of steel pipe, and then placed in a lathe, where the spherical surface was accurately formed with proper tools. The bearings for this spherical surface are formed of lead, which was melted and poured into the channel rings of the socket and collar after the parts had been assembled in the shop. This style of joint was originally designed several years ago by Mr. William H. Law, of Peterborough, Ont., for use in the 4 ft. and 5 ft. intake pipes of the Toronto Water Works, and was also adopted for the 4½ ft. intake pipe of the Syracuse, N. Y., Water Works.

In its original form, however, the chord subtended by the two lead bearings seemed too short, and in designing the joints used at Hemlock Lake, the chord was lengthened considerably by using angle rings of unequal sides. The joint was also greatly strengthened by the introduction of the heavy steel re-enforcement rings above or around the bearings. It should be remarked that all of the steel angle, channel and bar rings were carefully welded, and then riveted together, as shown in the drawing. The 5 ft. flexible joints referred to weighed about 6,200 lb. complete each, the weight of the cast iron zone or ball portion being about 2,700 lb. They were made by the Central Bridge and Engineering Company, of Peterborough, Ont., at the rate of $290 per joint, including all transportation and attachment to the pipe at Hemlock Lake, but exclusive of the United States customs duty. The steel plate of the pipe is ⅜ in. thick where heavy back filling of the dredged trench or channel was contemplated, and $\frac{5}{16}$ in. thick where the back filling was light or where the pipe lies directly upon the bottom of the lake.

WIRKL. GEH. OBERBAURATH OTTO BAENSCH, ENGINEER OF THE NORTH SEA SHIP CANAL.

After the joints had been riveted to the pipes, their weight ranged from 14·5 to 18 tons each, according to the thickness of the plate and the number of stiffening angle rings applied to the pipes where heavy back filling occurred. The pipes were laid in water varying from 20 to 35 ft. in depth, each joint being securely bolted together above the surface of the lake, and then lowered into place on the bottom by means of suitable apparatus. All of the joints appeared to move freely and satisfactorily in every respect and to be quite watertight. As before stated, the pipe was designed for intake purposes only, and will probably never be subjected to a greater external pressure than that due to about 1 ft. head of water. Slight leakage was therefore a matter of no particular account. There is, however, no reason for believing that the flexible joints here used would not be thoroughly serviceable if subjected to internal water pressure.

In designing such flexible joints, it is essential to proportion the parts so that the bell or socket will not

* Abstract from a paper read March 6, 1895. From the Transactions of the American Society of Civil Engineers.

THE NORTH SEA SHIP CANAL—THE ENTRANCE AT BRUNSBUTTEL, ON THE ELBE.

burst under the severe internal pressure developed by the action of a force in the direction of the axis of the pipe. For this purpose the reinforcement of a cast iron bell or socket with a heavy ring of wrought iron or steel is generally expedient, and has frequently been employed in the past.

The use of a long subtended chord and a high versed sine is also very desirable. In the case of the Willamette River pipe, it is stated that a water pressure of 250 lb. per square inch was applied to a portion of the line, one end of the pipe being temporarily capped. A longitudinal force of about 154,000 lb., or 77 tons, was thus developed, which tended to pull the joints apart; and if the radial component of this force at the

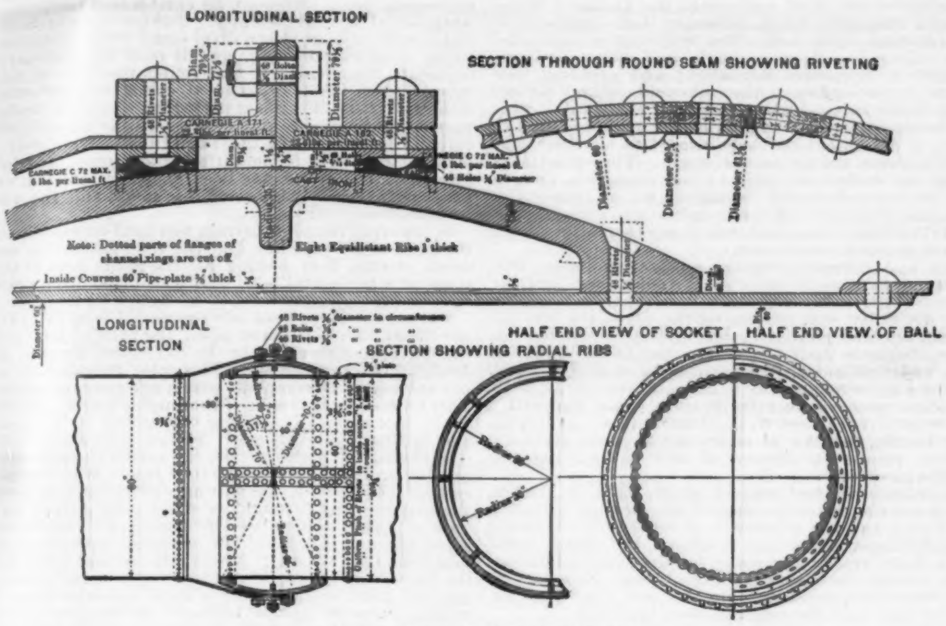


FIG. 2.—HEMLOCK LAKE PIPE.

junction of the socket with the collar be computed, on the assumption that the same is distributed over a width of 3 in. along the inner circumference of the socket and collar, it will be found that the lead was then subjected to a pressure of about 1,100 lb. per square inch. For this particular case the half chord is 3·75 in., and the versed sine 0·855 in.; but if the collar is also considered, the half chord becomes 6·75 in. and the versed sine 1·173 in. These favorable dimensions and the heavy flange of the socket doubtless prevented the loss of more pipes during this severe test.

The pipe was laid in September, when the water was comparatively warm, and the joints were pulled to a tight seat by the great longitudinal force above named. Assuming that a fall of 25° Fah. in the temperature of the water will occur in the following winter, a contraction or reduction of length amounting to 1 in 6,500 in the cast iron pipe will occur, which will produce another powerful longitudinal force. If the lead in the joints be regarded as unyielding, this force will be about twice as great as the one caused by the aforesaid test pressure, which produced a stress of about 1,100 lb. per square inch in the lead packing; hence the contraction will cause a stress of about 2,200 lb. per square inch on the packing, whereby the metal will probably yield or flow. The socket flange should therefore be proportioned to resist a pressure of from 1,800 to 2,000 lb. per square inch, which seems to be the point at which lead begins to flow; and it is evident that this has been done in the case of the Willamette River pipe.

The remarkable tightness of the joints in this pipe is very gratifying, and it is to be hoped that other experiments will be recorded which will bring out more fully the merits and reliability of such constructions. It may be urged that while a pipe line of this kind may be tight when first laid, the effect of changes of temperature will eventually give rise to leakage at the joints, and it would be interesting to learn whether such leakage varies with the seasons, being more in summer and less in winter.

Thomas H. McCann, M. Am. Soc. C. E.—About 14 years ago, during the laying of a 20 in. force main of which he had charge, it was necessary to submerge the pipe across two tidal rivers, each being about 400 ft. wide, with firm mud bottom and slopes of about 12 in 100, the range of tide being about 5 ft. There was no dredging done. "Ward" joints were used, the calking being done on one shore, and the pipe then hauled across the river as each joint was completed, a 40 horse power engine and heavy chains being used for the purpose. As each joint entered the water, two ordinary standard oil barrels were lashed firmly to the pipe which served to buoy it. When the end of the main had reached far enough up the opposite shore to allow for the extension due to settlement, the barrels were gradually cut loose, and the pipe settled slowly to the bottom. After the water was turned on, a diver was sent down to examine the joints, but he found no leaks. The pressure was about 90 lb. to the square inch. The maximum depth at high tide in both rivers was 21 ft.

The main has been in constant use during the last 14 years, and an examination made by a diver each summer shows that no leaks have occurred. The pipes are now about half their diameter in the mud. At one of the banks where the main enters the water down a steep slope of about 30°, one joint on the edge of the shore has pulled out about 2 in. The time occupied in submerging the main at each river was about a week. Mr. Miles Tierney was the contractor.

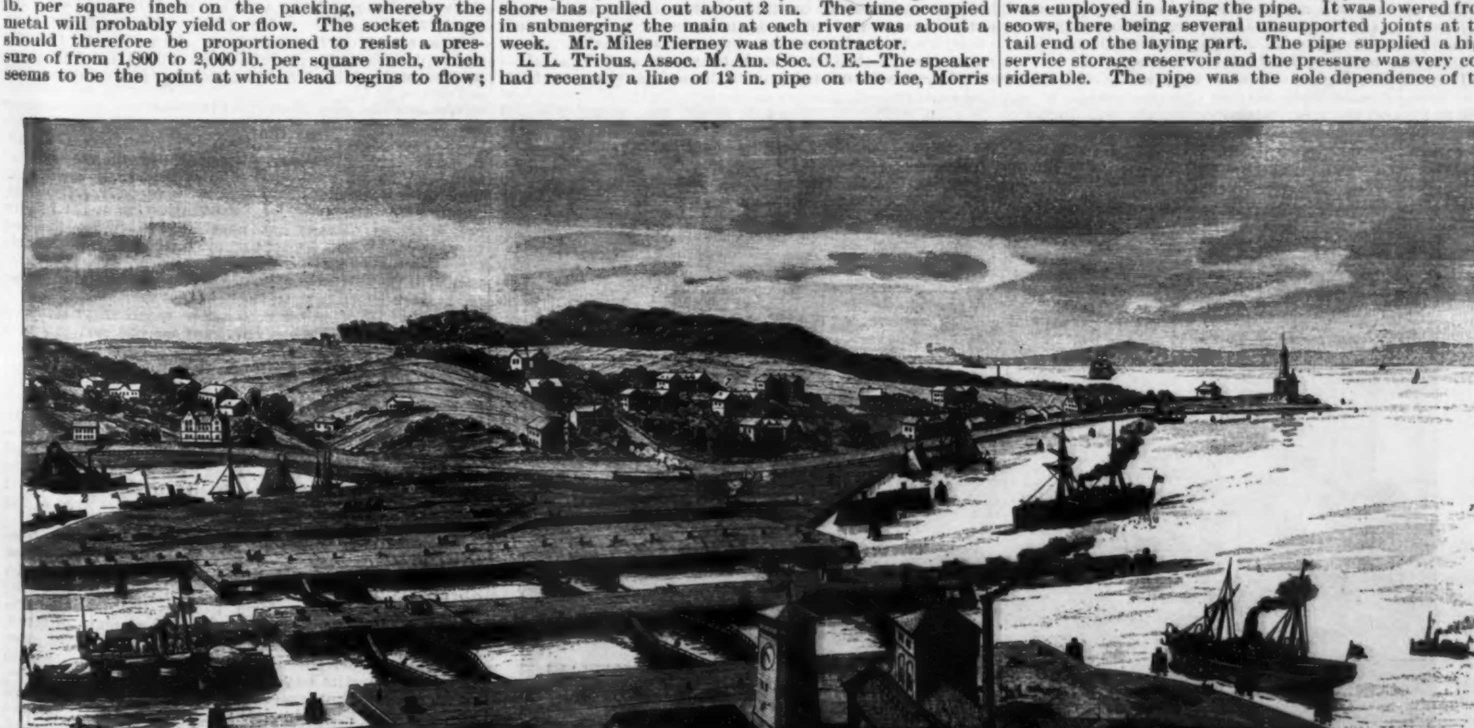
L. L. Tribus, Assoc. M. Am. Soc. C. E.—The speaker had recently a line of 12 in. pipe on the ice, Morris Lake, New Jersey, and knew the contract price, and about what the actual cost was as well. The ice was some 10 to 14 in. in thickness. A Ward spherical joint was used every 48 ft., there being two lengths of pipe with ordinary bell joints, then a pipe with a Ward spigot, then one with a Ward hub, each length being 12 ft. long. These were laid on the ice, blocks being put underneath and ropes fastened to a tackle on both sides of the pipe. It was then lowered in water from 6 to 12 ft. in depth, about 50 ft. at a time. After it was laid, it could be seen gradually settling in the mud, owing to the clearness of the water. It seemed to go down very successfully, but tests, to be applied later, can only determine the leakage. This line was about 1,400 ft. long, the pipes averaging about 1,000 lb. per length. The other line was about 700 ft. in length, laid in water from 10 to 24 ft. in depth, going down equally well, apparently with very little leakage. The question of leakage is comparatively unimportant, as the pressure is very slight and the supply very abundant. The two lines will eventually be connected through a masonry dam, and form the upper or intake portion of the delivery main for supplying Newton, N. J., some 8 miles away.

Charles E. Emery, M. Am. Soc. C. E.—His experience was confined to laying pipe with ball joints in trenches on land instead of under water, but he had been much interested in the work of Mr. Ward and others, who had succeeded in constructing water pipe which was flexible while being laid and would remain tight under practical conditions. Referring to the defects mentioned in the paper, he considered from his own experience that it is as easy to turn a ball as to face a plane surface. The tool has but to be guided in a circle and properly set, and the surface operated upon will be spherical. Details are important; for instance, it is necessary that the point of the tool be at the level of the lathe centers, and, in case the tool be carried by a revolving tool rest on the lathe bed, that the center of this rest be in the center of the shears, or in the vertical plane of the lathe centers; also, that by this method the point of the tool must be at the right radial distance from the center of the tool rest. When laying the steam pipes of the New York Steam Company, he had placed a globular joint every 40 to 50 ft. to remove all strains due to changes in line or grade, and there never was a particle of trouble with any of them. The joints were made in that case with very thin copper, covered with a thin coat of paint, and on breaking such a joint contact was shown all over the abutting globular surfaces. There should be no more difficulty, with proper tools, in obtaining spherical surfaces as accurate as ordinary plane surfaces, as it only requires intelligent inspection, based on knowledge of the way work is practically done in a shop.

The inspector must not only be familiar with the result to be attained, but, as a safeguard, he should for unusual details examine the construction and method of operation of the tools, when, with reasonable care, the work will be right. The apparatus used for turning the globular joints of the Steam Company consisted simply of a link of the proper radius hinged at one end to an ordinary traversing tool rest and at the other to a stationary frame, the traversing screw having been removed. With this construction the tool rest had only to be fed longitudinally by the motion of the carriage along the lathe shears when the transverse motion required to give circular movement to the tool and form a globular surface was furnished by the swinging of the link.

Billiard and other balls are turned by means of a revolving cutting tool on an arbor transverse to the axis of the lathe, the stock operated upon being meanwhile revolved in the ordinary way.

Foster Crowell, M. Am. Soc. C. E.—In 1868 or 1869 a submarine main was laid across the Schuylkill River with flexible joints that must have been one of the very first instances of the use of the Ward joint. No cradle was employed in laying the pipe. It was lowered from scows, there being several unsupported joints at the tail end of the laying part. The pipe supplied a high service storage reservoir and the pressure was very considerable. The pipe was the sole dependence of the



1. Harbor. 2. Deep dredging machine. 3. (Old) Holtenau. 4. Canal. 5. Lock plateau. 6. Closed gates. 7. Group of dwellings occupied by those employed on the locks. 8. Indicator tower. 9. Electric plant. 10. Machine shops. 11. Temporary gates, to be used during repairs to lock. 12. Boat landing, Holtenau. 13. Lighthouse. 14. Kiel roadstead. 15. Future torpedo harbor.

THE NORTH SEA CANAL—THE LOCKS AT HOLTENAU, NEAR KIEL.

reservoir, and he believed that the joints proved entirely satisfactory.

In the Ward joint practical watertightness seems to be secured without the additional refinement and cost of manufacture advocated by some eminent engineers to secure perfectly fitting spherical surfaces.

CORRESPONDENCE.

John F. Ward, M. Am. Soc. C. E.—The first trouble mentioned in the paper was "that the ball ends of the pipes had not been finished to a truly spherical surface." The method of inspection by micrometer measurements as used in finding the amount of imperfection in form is called by the authors "crude," but, perhaps, "badly chosen" would convey the idea better. Attention is called to a far simpler method of detecting the inaccuracy of the zone of a sphere, which is to use a plain ring of suitable size (which in this case would be about 18 in. in diameter), bored

SUBMERGED PIPE LINE.

and faced truly in a lathe. This, if simply laid on the alleged spherical part of the pipe, will show by its contact whether there are any high places, and a flat space of 1⅛ or 2 in. in width would show in a rather startling manner, without the work of calculating the ordinates of the curve.

The experience gained in this work shows clearly that the bad turning of the ends of the pipes did not in any degree prevent a very good result, and the securing of a reliable and, in every way, first class job. The apparatus used for depositing the pipes in the trench and the method of operating it was not new; it was clearly shown in Engineering, vol. xi, page 398, London, 1871.

He thought the starting of 650 ft. of the line of pipe, weighing 200 tons, by a water pressure of 350 lb. per square inch in the pipe, an interesting piece of experience, as it shows a static friction on a sand and gravel bottom of considerably less than 50 per cent. if the joint at the large end of the reducer was the one which was started by the pull, or less than 38 per cent. if the small end was the one that moved.

If both joints were equally well made, the larger one being the stronger only in the proportion of say 100 to 87, and the relative proportionate pull being as 100 to 76, the larger joint should have moved.

James Duane, M. Am. Soc. C. E.—He had laid a number of lines of submarine water pipe, under various conditions, and is now making a design for a 36 in. flexible jointed main. The paper is of great interest, especially the sketch and description of the cradle used, but he believed that the form of joint employed by the authors is in every way inferior to either the regular Ward joint or to that designed by himself and adopted as standard by the Croton Water Department, New York.

The fact that two of their joints failed under the pull due to the pressure used in testing shows structural weakness that would have been fatal to the success of a line laid under the extremely unfavorable conditions that are sometimes encountered here.

It is questionable if the convex ball spigot can be as readily or accurately turned truly spherical as can the concave hub, still the excessive accuracy demanded by the chief engineer of the Portland Water Works seemed to be unnecessary, and unattainable at any reasonable cost. The writer never demanded nor expected such close work, and never had any trouble as to perfect flexibility; and granting that slight imperfections in the spherical turned surface may cause leakage when the joint is rotated, it must be remembered that the tightness of joints of this form is dependent on their being laid on their final bed under a strong tensile strain. This practically calks the entire lead joint at one operation, and, as the lead is sufficiently ductile to fill all reasonable irregularities, and sufficiently inelastic to remain where put, the slight departure from theoretical form cited is of no practical importance.

He also differed from the authors' statement that "the advantages in favor of the long pipes are obvious." His experience had been that the greater the flexibility, viz., the shorter the pipes, the less the strain on each joint in laying, and the better the line accommodates itself to irregularities in the bed. In the first line laid 12 ft. lengths were employed which he had since reduced to 9 ft. as a standard, while in some cases, where extra flexibility was required, 6 ft. lengths were used to good advantage. For splicing breaks, lengths as short as 4 ft. have given excellent results on account of ease of handling and shortness of curve.

Although the first cost of short pipes is greater, they are preferable because of the greater certainty in laying and the avoidance of necessarily expensive repairs, especially those involving the employment of a diver, and amply repay for the small additional cost; while, in case repairs do become necessary at any time, the more flexible the line, the more expeditiously and cheaply can they be made.

A main he had laid to Ward's Island embodied all the good points and remedied the defects brought out in an extensive experience. The special features of this design are the wrought iron reinforce band shrunk over the hub, and the rounding off of the sharp cutting edge at B (see engraving). This band,

THE WARD'S ISLAND PIPE.

when properly proportioned and shrunk on, absolutely insured the hub from bursting against any tensile or cross strain to which it could reasonably be subjected.

In repairing a line on which a large vessel had sunk, it was necessary to break the pipe in several places in order to obtain free ends to splice. To accomplish this, the powerful derrick of a wrecking boat was used, and the joint parted either by the spigot shearing through the lead joint or, in case of sharp bending, by the crumbling away of the inner edge of the hub at B to a sufficient extent to allow the spigot with its lead ball to escape. In no case was a hub split, which is the usual method of failure with the ordinary cast iron pipes.

In the first pipe line laid, the sharp cutting edge was left just as it came from the planer. It was soon found, however, that when the joint was rotated, this sharp edge itself acted as a plane and took off a shaving of lead at each motion, with the result that it was extremely difficult to pull the joints tight afterward. The rounding above mentioned obviated this difficulty satisfactorily.

The following brief description of the worst break he has yet had to repair illustrates the facility with which this form of pipe may be handled even under unfavorable conditions.

A 12 in. line laid across the East River (Hell Gate) to Blackwell's Island parted in about 70 ft. of water, where the great depth of water, the irregular, rocky bottom and the great velocity of the current (6 to 8 ft. per second being common), all combined to make the work one of special difficulty. The intervals of slack water were so short that a diver could work only about thirty minutes to a tide, and it took him two days to locate the break. It was found that one of the wrought iron bands had parted, owing to a defective weld, and that the unsupported hub had then split, permitting the line to pull apart. This is the only accident due to this cause that be ever had. The broken ends were brought to the surface about noon, and before night the splice had been made, by inserting six 4 ft. lengths, the pipe lowered into place, and the water turned on.

In lowering the pipe a strain was kept constantly on the right of the pipe line and the scow allowed to sag down stream, thus pulling all the joints taut in the shape of a horizontal bow. This occurred four years ago, and the pipe has worked all right ever since.

The cost of these lines laid has varied from $7 to $11 per linear foot, dependent upon the price of iron and the natural difficulties to be overcome, amount of dredging, excavation, etc. This price includes all labor and materials complete, with a one year guarantee. This form of joint had been thoroughly tested, and he could recommend it as being economical in first cost, and as thoroughly efficient. It is not patented

In closing, he wished to ask the author the following questions: How were the joints run? Was the rib cast on the inside of the hub an efficient stop against the lead running through, or was a yarn gasket, clay dam or other similar device employed? Were the joints run and calked in two separate operations, as described by Fanning? His experience had been that the lead should be run at one pouring to make a homogeneous joint, and that this is more essential than is calking to insure against leakage. If the pipe is laid under a suitable tension, calking may be omitted entirely without ill effects.

H. F. Dunham, M. Am. Soc. C. E.—The paper, although a valuable one, is unlike many others in being too brief. A paragraph or two in relation to the main channel, the amount of shipping for which provision had to be made and the controlling factors in the design of the work would have been acceptable, as also a few general facts in regard to cost, such as the difference in price per ton between common pipes and the pipes purchased, the cost of lathe work, cost of cradle, etc. While the work was undoubtedly carried out to the satisfaction of the parties interested, still questions naturally arise which may be without the province of the authors to answer; as, why, for instance, were the elaborate cradle and its appurtenances constructed? Why was each joint a flexible one? Or, why were any flexible joints at all introduced? And, why was the integrity of an important line left dependent upon the threads of 1 in. iron bolts and nuts which may be exposed in the river bottom to corrosive substances? It does not appear from the description of the material in the bottom of the river that any movement of the pipe due to shifting channels or any other cause is to be anticipated. The description and the sketches alike fail to show any reason why a submerged line could not have been laid with common pipes and bell joints, each one of which would be as good as joints made on dry land and a few of them rather better than such ordinary joints. For nearly ten years, work of this kind has been successfully and cheaply carried out by contractors in this country for river crossings, lake intakes, etc. Nothing more plainly shows the difference in the two methods and the great advantage of the modern way than the attention given to tests as the work went on. Had the line been laid in sections with rigid joints, the test would have been scarcely more worthy of remark than would the test of the same length of that size of pipe laid in dry ground. The work described appears to have been important enough to warrant exact information in regard to its condition. If a leaky gate prevented this it would have been worth while to repair or replace it. Too much stress seems to have been placed upon exact measurements of parts and too little upon the relation those parts were to sustain to the whole work.

It would be of interest to know whether gravity or the barge assisted when the joint at the reducer was drawn out quarter inch, and how the proper endwise stain or pull upon the submerged line was continued when the connection was made with the larger pipe at the completed end. An end pressure test for each pipe is referred to as having been omitted, and although the conditions for testing are not fully described, it would appear that each length, or at least the greater portion of it, must have been subjected to an endwise stress of 400 or 500 lb. to the square inch while in the testing machine. The greater area of the bell end insures this.

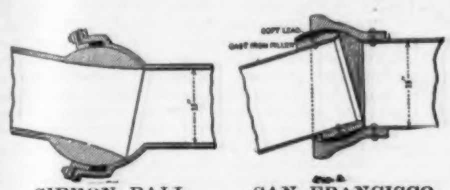
The flexibility of a line of cast iron pipe as ordinarily laid is greater than many suppose. A 10 in. pipe of the writer's design across a river 1,000 ft. wide with abrupt banks was put together with bends and common joints so as to conform to the dredged channel, then tested and lowered into place by means of screw rods operated by a dozen men. The first man gave his hand wheel three turns and then went to the next, two lengths beyond, which he also turned three times, and at the same time the man who followed him gave the first wheel three more turns, then three men, four men, etc., followed until all were at work and carried an undulatory motion or wave in the line pipe back and forth across the river until it was lowered about 10 ft. While still suspended, fine rip rap was filled into the trench, to insure a good bearing. No diver was employed. This pipe line seemed perfectly tight, as it held up the gage pressure. This

SUBMERGED PIPE LINE, PORTLAND, OREGON.

was six years ago, and no trouble has yet occurred. The pressure varies from 60 to 140 lb. It is not, however, implied that heavy work should be done in this manner.

L. J. LeConte, M. Am. Soc. C. E.—The ball joint adopted is of excellent design in many respects, but rather too expensive for common use, there being too much nice turning required. The most useful ball joints of to-day are but modifications of the old ball-and-socket or universal joint invented by Mr. James Watt for the Glasgow Water Works Company in 1810, which laid in that year an inverted siphon 1,000 ft. in length across the River Clyde. This was of cast iron 15 in. diameter in 9 ft. lengths with flange joints, and had ball joints interposed at variable distances, depending upon the profile of the bottom of the trench. The length of the sections between ball joints was generally 28 ft. 6 in., except at the middle of the line, where a single 10 ft. length became necessary in order to fit the ground. The ball surfaces were not turned at all, being made watertight by means of an adjustable packing joint similar to an ordinary stuffing box.

The details of Watt's 15 in. siphon ball joint are shown. This pipe line was laid on strong frames,



SIPHON BALL JOINT. SAN FRANCISCO JOINT.

made of parallel logs; these frames were joined by strong iron hinges, having their pivots in horizontal lines at right angles to the axes of the pipes and passing through the centers of spheres, of which the zones of the sockets are portions. The flexible joints are at the extremities of the frames. The frames and pipes were put together in succession on ways situated on the south side of the river, and the open or north end being plugged, were hauled into and across the bed in a trench prepared for them. The hauling machinery was, of course, on the north bank. The operation was quite simple, being aided by the flotation of the framework and the buoyancy of the empty siphon, assisted and directed by pontoons. The movable joints and hinges of the frames allowed them to conform to the bed.

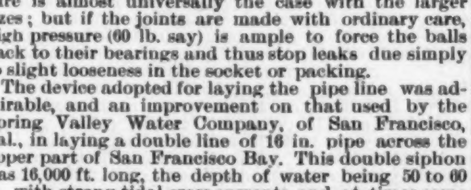
The water company put in another siphon, 18 in. in diameter, in 1830; a third siphon, 25 in. diameter, in 1838; and a fourth siphon, 40 in. diameter, in 1840. All of these were put in under the same plans.*

The longitudinal "pull" mentioned by the authors always exists more or less and invariably tends to tighten the ball joints. In case of wrought iron and steel pipe this "pull" is also partly due to swelling of the pipe under high pressure. In extreme cases the shortening of the pipe line is quite marked.

Leakage at the top of the ball joint under low pressure is almost universally the case with the larger sizes; but if the joints are made with ordinary care, high pressure (60 lb. say) is ample to force the balls back to their bearings and thus stop leaks due simply to slight looseness in the socket or packing.

The device adopted for laying the pipe line was admirable, and an improvement on that used by the Spring Valley Water Company, of San Francisco, Cal., in laying a double line of 16 in. pipe across the upper part of San Francisco Bay. This double siphon was 16,000 ft. long, the depth of water being 50 to 60 ft., with strong tidal cross currents and at times some very heavy seas. The ball joint adopted for this work is shown in the engraving, and was very cheap and efficient.

Where the siphon is subjected to sharp bends, a good deal of head is lost by friction at the ball joints. This difficulty is greatly relieved by the modification introduced in the Badois joint, in which the rear por-



THE BADOIS JOINT. THE VON SCHMIDT JOINT.

tion of the socket or casing is made in the form of a long frustum of a cone. This reduces friction very much. The Von Schmidt joint is shown in the engraving.

James D. Schuyler, M. Am. Soc. C. E.—In June, 1893, the writer was called upon to make a report to the Water Committee of the city of Portland, on the subject of the most desirable method of effecting the crossing of the Willamette River with the pipe which forms the subject of this paper, and was engaged in planning and constructing the system of distributing reservoirs in connection with the same plant at the time the work of laying the pipe was performed. The first examination, to which two weeks were devoted, demonstrated that considering the elements of time and cost of governing, no other method of effecting the crossing of the river was practicable but to lay a flexible joint submerged pipe under the river bed. The possibility was contemplated of using one of the four existing bridges spanning the river to carry the pipe, submerging it only at the short draw span, but as none of them had been designed to carry such an extra load the plan was manifestly impracticable. But for the lack of time to organize and combine with the city and county for the purpose of constructing jointly a new bridge designed for the purpose, and located about one mile up the river from the highest existing bridge, where high bluff banks admit of erecting a bridge high enough to clear river craft at all stages of water, that plan of crossing would have appeared the most desirable. The pipe would then have been accessible always and the ordinary cast or wrought iron pipe could have been used, while the maximum pressure might have been reduced some 40 lb. per square inch by having the entire pipe nearer the hydraulic grade line. This plan not being feasible, the submerged pipe laid in a trench to be dredged some 12 ft. deep in the river bed was the one recommended, substantially as previously planned, but with the following modifications of the plans:

First.—The diameter of the river section was reduced to 28 in., or if two pipes were considered desirable as a measure of precaution, both were to be 28 in. in diameter, but laid 100 ft. apart, that the breaking of one might not undermine and destroy the other.

Second.—The total length of flexible pipe was shortened by laying it only to the low water line on each side instead of to the high water line, thus effecting a considerable saving in distance of the more expensive pipe.

Third.—The pipe was to be made of wrought steel, with butt joints on the longitudinal seams and cast iron ball and socket joints. The balls were to be turned and fitted in the shop, joints poured and one end riveted, the work in the field to be only the riveting of the other end. Bids were to be taken also on aluminum bronze ball and socket joints.

Fourth.—The location of the crossing was to be changed from Clay Street to a line extending from the foot of Stephen Street on the east side to the foot of Mill Street on the west side, which location is 500 to 800 feet higher up the stream.

Fifth.—Y branches and valves were to be placed on the main at some convenient points above high water mark on each side of the river, for connection with a second pipe to be laid either across a high bridge, if such be built, or under the river, 100 feet away from the first pipe.

The reasons given for these recommendations, which were accepted by the chief engineer, and adopted by the committee upon his report, were in substance as follows:

The reduction in diameter from 33 inches, which had been fixed upon for the diameter of a single line of pipe subsequent to the rejection of bids upon a double line of 24 inch pipe, was recommended because it could be accomplished without materially affecting the capacity of the main and for the reason that without changing the thickness of the metal the strength could be increased in the ratio of 7 to 6, and the weight reduced 10 to 12 per cent., enabling the pipe to be handled with greater facility and reducing the chances of accident. The capacity of the main to the high service reservoir was computed at 22,325,000 gallons daily, in full section throughout, or 21,800,000 gallons with the submerged section reduced to 28 inches, while if delivery were made at the low service reservoir direct, where at least 85 per cent. of the west side water was to go ultimately, the capacity, even with the reduction in diameter at the river, would be about 28,400,000 gallons daily, which is greater by 3,000,000 gallons than the entire capacity of the Bull Run pipe, which has to supply both sides of the river. The only reason for the delivery of the low service water through the high service reservoir on the west side is to utilize the power afforded by the drop from high to low service for pumping a small supply to levels 500 to 600 feet higher, which power can at any time be replaced by steam, and the pipes left to deliver their utmost capacity where it may be needed, regardless of the power question.

The preference given to wrought steel over cast iron was chiefly on account of the longer lengths and fewer joints with which it might be laid, and under the supposition that 13 feet was about the longest length at which cast iron pipe was ordinarily made. The contractors succeeded in obtaining cast iron pipe in 17 feet lengths, which reduced the number of joints supposed to be necessary by 23 per cent.

The change in location was recommended because it was manifestly a better line in many respects, with a more uniform and firmer bottom, with coarser gravel, less liable to scour, requiring less dredging for the pipe trench, having better approaches, besides being somewhat shorter.

Specifications were prepared in accordance with these recommendations, but calling for bids on cast iron pipe in addition to the steel pipe, the result of which was that the lowest tenders for cast iron being about $14,000 less than the lowest bids for riveted steel, the cast iron was given preference, chiefly, if not solely, on economic grounds.

The bids for steel pipe ranged from $68,000 to $164,640, the latter being the bid for aluminum bronze ball and socket joints with steel butt joint riveted pipe. For cast iron the bids ranged from $54,000 to $113,580. The prices asked for laying varied from $2.50 to $19 per foot. The increased cost due to the revision of the bid of the Oregon Bridge Company referred to in the paper amounted to about $13,000, and this and some extras brought the total cost of the submerged pipe, 2,000 feet in length, up to $79,885.

The saving to the city which can be directly traced to the recommendations of the consulting engineer on the basis of the contract prices amount to about $40,000 over the double line of 24 inch pipe which had been contemplated, or about $35,000 over the single line of 33 inch pipe, a circumstance which is referred to without any desire to claim any special merit or achievement, but as indicating the value of calling an outside engineer in consultation, one who can view local conditions with new eyes and from a different standpoint.

The successful laying of this pipe under numerous difficulties was a creditable piece of work, and the mechanical appliances employed were ingenious and well planned. The cradle on which the pipes were laid while the joints were being poured, and down which they slid to the bottom on a true 10 degree curve, was specially applicable to the conditions of this case, although in rougher waters or with depths over 40 to 45 feet such a cradle would be too severely strained to be practicable.

The authors refer to the fact that during the experimental tests of the first joints laid out from shore "the leakage was in every case confined almost entirely to the upper portion of the joint, the extreme lower portion being tight," and suggest that this was the result of the extreme weight of the pipe, "which the most accurate workmanship could not overcome."

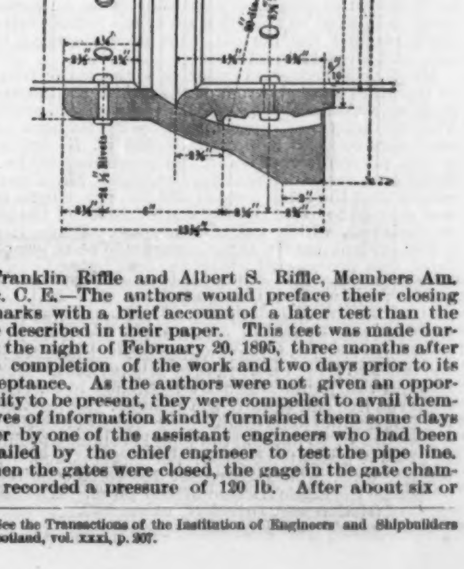
As the surface area of the lead in the lower half of the pipe is about 592 square inches, the weight of the pipe when lifted 4 feet at one end might produce a compression of the lead to the extent of about 0·008 inch, which would leave a space sufficient to account for considerable leakage, provided the pipe rested in lead alone, but, unfortunately for that theory, the projecting flange or ring of cast iron inside the bell, which forms the back wall for the lead in the joint (see engraving), acts as a rest and a centering ring for the spigot end of the male pipe, and would prevent any such compression in the lead, or any perceptible compression whatever. For this reason it seems that the chief cause of the leakage at the top of the joint, which was observed before as well as after the pipe had been raised and lowered, arose from sponginess in the lead, due to confined air in the lead space, caught during the pour without sufficient vent or escape, as well as to insufficient calking, due to the great depth of the lead.

The method adopted of pulling the joints tight by bolting on a head or flange and subjecting it to very high pressure at intervals of about 200 ft. during the process of laying was so palpably effective that it overcame all objections raised to the roughness of the turning of the balls. The pressure was sufficient to produce a more perfect calking of the lead than would have been effected by any other available means.

The question raised by the paper is as to whether this is a customary or desirable method of procedure in laying submerged pipes, and also as to whether greater perfection in turning is not ordinarily sought and attained than was given to the balls in this case. The double line of 16 in. pipe laid by the Risdon Iron and Locomotive Works, in 1887, for the Spring Valley Water Company, of San Francisco, across the Bay of San Francisco, was made with joints so perfect that when it was tested in the shop, under pressure as high as about five hundred pounds per square inch, and turned at all angles with the pressure off and on alternately, no leakage whatever was observable; hence it was not necessary to resort to pulling on the joints, by using high pressure at frequent intervals while laying, to make them tight after laying. In this joint hemp packing was used, and to its use much of the excellence of the joint was attributed. The construction and laying of this pipe is described in a paper* by R. S. Moore, superintendent of the Risdon Iron and Locomotive Works, from which the following facts have been gleaned:

The distance from shore to shore was 6,500 ft., of which 2,000 ft. in the center was from 50 to 60 ft. in depth. During the laying they experienced much rough weather, and at all times had to contend with a tidal current that was often as strong as six miles an hour. The motion of the vessel during time of high winds was occasionally so great as to prevent the pouring of the joints, and to compel the workmen to suspend work until the weather moderated.

The barge from which the pipes were laid was held in place by taut cables, anchors, and a firm lashing to the pipes, that were suspended always slightly above the shute where the pipes entered the water. No divers were employed, nor was the pipe pulled at all by applying pressure. (At Portland a diver was constantly employed calking joints under water.) Both pipes were laid simultaneously, side by side, in lengths of 18 to 19 ft., and consisted of lap-welded tube, galvanized or "kalameined," and double dipped in asphalt, the joints being made in cast iron, riveted to the tube. (See engraving.)



Franklin Riffle and Albert S. Riffle, Members Am. Soc. C. E.—The authors would preface their closing remarks with a brief account of a later test than the one described in their paper. This test was made during the night of February 20, 1895, three months after the completion of the work and two days prior to its acceptance. As the authors were not given an opportunity to be present, they were compelled to avail themselves of information kindly furnished them some days later by one of the assistant engineers who had been detailed by the chief engineer to test the pipe line. When the gates were closed, the gage in the gate chamber recorded a pressure of 120 lb. After about six or

* See "The Life of James Watt," by M. Arago, 1839. "History of the Water Supply to Glasgow," by John Burnet, 1869.

* See the Transactions of the Institution of Engineers and Shipbuilders in Scotland, vol. xxxi, p. 207.

eight strokes of the hand pump connected with the pipe line, the engineer directed his lantern to the gage and was much surprised to find that it recorded a pressure of 150 lb. As his instructions had been not to exceed the working pressure, 140 lb., the pump was stopped until the pressure receded 10 lb. It was then found necessary to pump 5 gals. of water into the pipe line to hold the gage at 140 lb. for a period of 12 minutes. The apparent leakage was, therefore, less than ½ gal. per minute. The engineer, however, assumed that the gates leaked the same amount as when the previous test was made, viz., ¼ gal. per minute. As the pump, also, was in a leaky condition, he was forced to the conclusion that the line was practically tight, and so reported to the chief engineer.

The authors had hoped the discussion would bring out some important facts relative to the method of casting ball and socket pipe, reference to which was inadvertently omitted in preparing the paper. Both Mr. Kuichling and Mr. Duane emphasized the importance of reinforcing the socket, owing to the danger of fracture arising from tensile strains. In this connection, the fact should not be ignored that the quality of the metal in the bell or socket is sometimes much inferior to that in any other portion of the pipe, owing to the practice of some manufacturers to cast the bell end uppermost. This practice should be condemned, since the saving in cost scarcely cuts a figure in the matter. However conscientious and painstaking a manufacturer may be, impurities will rise to the top and become a portion of the shell. While the presence of slag and sand, and numerous blowholes adroitly filled with a combination of iron filings, sal ammoniac, and flowers of sulphur, concealed from view by the usual preservative, may escape the eye of the inspector, such imperfections are hardly consistent with what is generally understood by a "good gray casting." While an imperfect casting of this description might pass the usual hydraulic test, such a test would furnish no guarantee that it would successfully withstand great radial strains due to the wedging of the ball in the socket; hence, the importance of having the best metal instead of the poorest in the socket. This could be accomplished by reversing the usual practice of casting, in which case the impurities would rise to the last few inches of the ball, which is subjected to neither radial nor longitudinal stresses when in place, and being confined to that portion of the ball which is outside the limit of flexure, the rough surface, due to slag or blowholes, should such exist after machining, would not come in contact with the lead. While there may be some doubt whether a truly spherical and smoothly finished ball will require a longitudinal pull to secure a water-tight joint, it should, nevertheless, be borne in mind that conditions are always likely to exist when pipes are laid in the bottom of a stream, such as settlement or undermining, which may impose an equal amount of longitudinal strain. In view of these facts, the suggestion of Mr. Kuichling that the socket be reinforced by a band of wrought iron or steel is an excellent one. Mr. Duane's method of reinforcement is immeasurably superior to that used at Portland, for reasons which will appear later on.

As Messrs. Emery and Gould stated, perfect lathe work is always preferable to imperfect work, and with the requisite amount of care, "it is just as easy to turn the joints perfectly true as not to do so." However, the slight inaccuracies noted were not sufficient grounds for rejecting the pipes at the risk of delaying the completion of the water system for a period of one year, not to mention the palpable injustice of such a proceeding to the contractors, who had from the first acted only in good faith, relying solely upon the shop inspector appointed by the chief engineer. It was pleasing to note that an engineer of such wide experience and reputation as Mr. Duane had taken the same position. The latter's statement, based on experience, that the tightness of flexible joints is "dependent upon their being laid on their final bed under a strong tensile strain" is of great value, since it establishes the fact that, while it may be possible to secure tight flexible joints without this "tensile strain," under certain favorable conditions, such as light pipes and perfectly turned joints, the method of laying the pipes under tension insures absolute success under any and all conditions.

Concerning Mr. Ward's remarks, it should be said that in describing their method of laying submerged pipes the authors gave no thought as to whether the method was original with them or not, although at the time they prepared the plans for the cradle they had neither seen nor heard of a similar contrivance. Some time afterward, however, their attention was called to an illustration of an inclined plane used in laying a 24½ in. steel riveted pipe, with flexible joints, across the River Maas, in Holland. This device differed from the one designed by the authors principally in two respects, viz., there was no provision made for a change in the depth of water, and the slide being an inclined plane, admitted of no deflection at the joints until the pipes reached the bottom, thus necessitating a very long and unwieldy contrivance.

Mr. Ward's deductions relative to the static friction of the pipes on the bottom of the trench are incorrect, since no allowance was made for the action of gravity. The 650 lin. ft. of pipes tested to 250 lb. per square inch were on a descending grade, 190 lin. ft. being on a 12½ per cent. grade and the remaining 460 lin. ft. being on a grade of about 5½ per cent. Mr. Ward assumed that the total force of 250 lb. per square inch was exerted to overcome the static friction of the pipes on their bed, which was not the case. While it was quite evident that a large percentage of the applied force was necessary to start the lead in the large end of the reducer, the exact amount could only be a matter of conjecture. A more reliable frictional coefficient might be obtained from the experimental test of the first eight pipes laid, six of which lay level in the trench previous to its excavation below the water line, the last two lying on a grade of 12½ per cent. During this test the joints gradually tightened in succession from the free end toward the reducer, the leakage at the last flexible joint diminishing quite perceptibly at a pressure of 35 lb., and the joint becoming absolutely tight at a pressure of 45 lb. per square inch. The former, then, would represent the force required to overcome the static friction of the pipes. The coefficient of friction was, therefore, about 0·27.

Mr. Duane's questions are answered as follows:

First.—The lead was poured and calked in two separate operations, as described by Mr. Fanning.

Second.—The rib, which served as a lead stop, answered the purpose admirably, making the use of yarn unnecessary.

Third.—The pourings were made from a kettle, suspended over the joint by the derrick used for handling the pipes, and having an orifice in the bottom, which could be quickly opened or closed by means of a vertical screw. The lead should be run at one pouring, and calking was unnecessary; but as the work was done under the supervision of the chief engineer, the authors had no option in the matter.

The answer to Mr. Dunham's remarks is that the cradle was employed for the purpose of supporting the pipes until they reached the bottom of the trench, thereby avoiding excessive strains on the sockets, which would have occurred had the pipes been merely suspended from the pipe laying barge. Owing to the great weights of the pipes the latter method would not only have resulted in straining the sockets at the risk of cracking them, but would also have had the effect of wedging the shoulders of the ball ends tightly against the collars, so that the joints would have become inflexible, and many would, no doubt, have refused to accommodate themselves to the bottom of the trench.

The following were the probable reasons of the chief engineer for deciding upon the use of flexible joints:

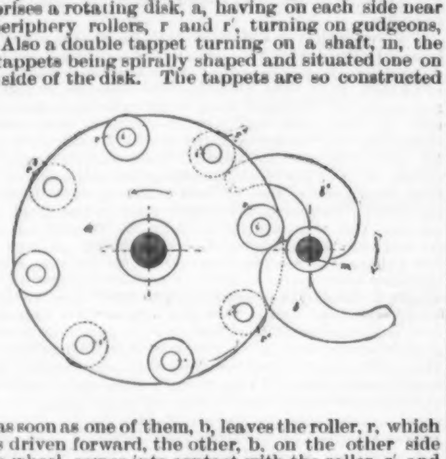
First.—The pipes could be laid without obstructing navigation.

Second.—They would readily conform to irregularities in the bottom of the trench.

Third.—In the event of possible shifting of the channel during freshets, there would be far less danger of leakage or rupture. As this is a portion of the main pipe line which supplies the city of Portland with water, the chief engineer was expected to take every reasonable precaution against accidents which would tend to shut off the water supply.

IMPROVED GEAR.

CARL HAMANN, Rheinbeck, Germany. This gearing is adapted for the transmission of great power, and comprises a rotating disk, a, having on each side near its periphery rollers, r and r', turning on gudgeons, i i'. Also a double tappet turning on a shaft, m, the two tappets being spirally shaped and situated one on each side of the disk. The tappets are so constructed



that as soon as one of them, b, leaves the roller, r, which it has driven forward, the other, b, on the other side of the wheel, comes into contact with the roller, r', and drives the latter forward. The tappets are formed to impart uniform movement to the wheel, a.

[FROM THE ENGINEER, LONDON.]

THE TIN PLATE INDUSTRY IN THE UNITED STATES.*

So much for the records of development up to the middle of 1894. In regard to the present condition and future prospects of the industry, a man who is an authority in the matter writes me as follows:

"All the older works were modeled after the Welsh concerns so far as tinning and pickling machinery is concerned, and some of the early departures did not prove a success. I do not believe that there is very much in the direction of marked modifications in devices, but that the larger amount of work done lies really in the greater efficiency of labor, and the absence of trade union restrictions as to quantity produced, etc. A close study of detail of appliances with the advantages due to newly designed plant might reveal an aggregate improvement of some consequence, but I do not believe, from what I know, that there have been any such revolutionary or sweeping changes as our English friends might have been looking for. As a matter of fact, from an economic standpoint, the most important circumstance in connection with the industry is that the steel for rolling costs very little more in this country than it does in Wales, and that therefore the duty more than compensates for the labor cost per unit of product; the greater willingness of labor to turn out product aids in this."

While it is no doubt true, as this writer says, that the main machinery is modeled after the Welsh plants, it seems probable that inventive ingenuity and the fact of designing a new class of machinery for this country have resulted in the introduction of important improvements, and of other improvements which, though small in themselves, are of importance as affecting the efficiency of the machine. In fact it is said that some of the older styles of equipment are already practically obsolete. A more radical difference between American and Welsh works is undoubtedly the greater use of economical labor saving machines and devices in the former, by which the number of men and the amount of the pay roll are very materially reduced. This matter will be referred to more fully in discussing the American works.

While the general financial and commercial depression of 1894 was severely felt by the tin plate trade, as by all other trades, it is generally considered that the outlook is improving, more particularly for the works of larger capacity of output.

With the price of steel billets ruling as low as $15—£3—per ton, and even less, sales having been made at $14.90 in March, it is admitted that those concerns which roll their own black plate and have modern equipped plants can realize a fair profit on tinned plate manufacture, even if paying the new compromise scale of wages noted further on; but it is said that an advance in price is not improbable, and that an advance of $1—4s. 2d.—per ton will suffice to wipe out the profit. One manufacturer operating under the above conditions stated in February that at the then existing prices his profit was only eight cents—4d.—per box, a margin so small that it would disappear with a slight advance in the price of billets, or a slight decline in the selling price of tin plate. This fact, coupled with the competition due to a production which bids fair practically to equal the demands, seems to point to a possible further lowering of wages.

As already noted the new and reduced duty of 1894 had a particularly strong and injurious effect on the firms known as "dippers," i. e., firms which merely dipped imported black plates. The new duty on these plates is 1·1 cents—0·55d.—per pound, with ⅛ cent—$\frac{1}{16}$d.—added on such plates when pickled and cold rolled, which are essential requisites for black plates for tinning. This makes the full duty on the black plates for "dippers" 1·22½ cents—0·61¼d.—per pound, or actually 0·02½ cent—0·01¼d.—higher than the duty on imported tin plate, which is 1·20 cents—0·6d.—per pound. These firms found, therefore, that they must either produce their own black plates or buy them in the open market. In regard to the first alternative, as most of these firms are in the Eastern States, they could not get the steel bars as cheaply as their Western competitors, and being near the seaboard, are at a disadvantage by foreign competition, although, on the other hand, they have the advantage of having cheaper labor and being nearer to important markets for their product. As to the purchase of black plates in the open market the Eastern dippers are not favorably located, as that particular branch of the industry has developed more in the West.

These difficulties, however, could not, of course, adversely affect the larger and more important works which make their own black plates. In fact, it rather aided them than otherwise for a time by reducing the number of their home competitors, a temporary advantage which was soon lost by the starting up of new plants for making black plates and tinning these plates. Many large steel works established tinning plants for treating their own output of black plates, while others, not wishing to go into the business of dipping and treating the plates and selling this product, have been encouraging and offering inducements for the establishment of tinning or dipping works in their vicinity, offering steel at a certain low price for a term of years, so that the manufacture of black plates and tinned plates may go on harmoniously, but conducted as separate enterprises.

There was some apprehension that the passage of the new Tariff act of 1894 by which the duty on black plates became actually higher than that on finished tin plates, as above mentioned, would lead to a shortage in the supply of black plates. This, however, did not prove to be the case, as the Welsh manufacturers, finding their tin plate not so much in demand in the United States as formerly, began offering their black plate to the American manufacturers, and even reduced their rates at certain points in order to enter into competition with local manufacturers of black plate. Nevertheless the output of domestic black plate expanded so considerably as to be able almost if not entirely to supply the home tinning or dipping mills, thus encouraging the latter in their turn to increase their dipping capacity.

A review of the industry in the Metal Worker of January, 1895, stated that numerous additions were made to the list of tin plate mills during 1894, many of the new mills being of large capacity and equipped with the most modern machinery and labor-saving appliances, and in fact, the United States has probably some of the most completely equipped tin plate works in the world. A few of the smaller dipping concerns went out of existence in consequence of the adverse legislation, but none of the larger concerns or those manufacturing their own black plate. Several works enlarged their plants and capacity by the erection of new buildings and the installation of additional and improved plant, while a few of the dipping works added black plate rolling mills to their plants.

"The number of tin plate plants that manufacture their own black plates has grown materially. Nearly all the latest additions to the list of American makers combine the two lines, while a large number of rolling mills have added, or are adding, tin mills for the production of plates for tinning purposes. The quality of the American black plates is admittedly excellent, and these are uniformly preferred by the dipping firms to the foreign material. Latterly the alteration in the duty on tinned and black plates has made the use of the domestic plates almost prohibitive to those manufacturing firms which do not roll their own material, and they have been forced, for economy's sake, either to revert to the use of imported plates or to shut down altogether. This difficulty soon may, and probably will, be surmounted when the wage question is settled,* and the manufacturers are able to reduce the price of American plates through reductions in the price of labor and the adoption of more economical processes, although black plates are already down to the lowest price known. A number of iron and steel mills have erected tin mills during the year, and the production of black plates for tinning is likely to be immensely augmented this year—1895. So far, the supply has been hardly adequate to the demand, and in the busiest quarter of last year—that ending September 30—the complaint was often heard from the tin plate makers of inability to obtain a sufficient supply of black plates to keep their works running as actively as their volume of orders necessitated. This drawback will probably not be felt again.

"The American works are producing both tin and terne plates in all sizes and grades, of a quality equal and, in some instances, very superior to those imported from abroad. The home consumers are becoming largely convinced of the merits of the native plates, and—particularly in the West—are reported to be discarding the use of the foreign article entirely. The

* Continued from SUPPLEMENT, No. 1019, page 16289.

* Settled in January according to terms recorded further on.

American roofing plates have for some time past firmly established their reputation. Many brands of these plates are now almost as well known throughout the United States as the old Welsh standard brands. The bright plates are now coming more and more to the fore, and are by degrees displacing the Welsh material in certain sections."

The inquiries and demands for the machinery used in the trade also point to a further growth and development of the industry.

The next question to be considered is that of the capacity of the output and the amount of consumption. The question of the capacity of the American tin plate works and their production or overproduction is being much discussed at the present time, and a consideration of the arguments and statistics leads to the conclusion that the present capacity is approximating closely to the present demand for domestic consumption, from which it may reasonably be inferred that the manufacturers will eventually be seeking to extend their markets. Taking an unfavorable view of the case, one writer, who is largely interested in the American tin plate trade, gives his impression that by the end of the current year domestic manufacturers will have to face a strong home competition due to an overproduction of about 30 per cent. This opinion is based upon the following rough calculations as to consumption and capacity of output:

(1) The total annual consumption of tin plate in the United States is 6,000,000 boxes.

(2) The Standard Oil Company, which is the largest individual consumer, uses 900,000 to 1,000,000 boxes annually, upon which it is allowed a rebate of 99 per cent. of the duty, and this company may thus be assumed to be out of the reach of the competition of American manufacturers at home prices.

(3) The Pacific coast trade amounts to between 500,000 and 1,000,000 boxes annually, and this is also out of reach of the competition of American manufacturers, as the English manufacturers can ship so much cheaper by water.

(4) The manufacturers of dressed beef who export their product are entitled to a 99 per cent. rebate on the duty on imported tin plate used for their shipments for foreign markets—in the same way as the Standard Oil Company. These firms are said to prefer buying foreign tin plate, owing to the fact that if they used in their canning factories American tin plate for material for home markets, and imported tin plate for material for export for foreign markets there would be required a complicated system of records, sworn statements, certificates, etc., to satisfy the government officers that the imported tin plate was not being used for material for home markets.

(5) From the above figures, this writer estimates that there are at least 2,000,000 boxes of tin plate consumed in this country annually, which, he argues, will always belong to the Welsh makers until the labor conditions, etc., in this country approximate to those existing in Wales.

(6) Therefore, he estimates, there is only an annual demand, in good years, of 4,000,000 boxes to be competed for and supplied by American manufacturers; and as, according to the estimates of himself and others, the mills now in operation and in course of construction have an aggregate annual capacity of 5,000,000 to 6,000,000 boxes, the American manufacturers will have to face a home competition due to this overproduction of 30 per cent. This would certainly not be encouraging, even if the building of tin plate plants should not go beyond those already under contract; but, as a matter of fact, new works are continually being projected.

Taking the figures just given above, the Metal Worker has discussed the question at length, and the main parts of its arguments may be abstracted as follows:

"It is difficult to estimate with any degree of accuracy the aggregate capacity of the tin plate works now in operation or in course of erection in this country, but, as far as we have been able to judge from a necessarily rough calculation, based upon reports of the proposed capacity of the new works—and these reports seldom err in the direction of underestimation—their capacity, together with that of the existing works, will most probably not exceed the lower figure quoted—5,000,000 boxes per annum—and that only if the entire capacity was in constant employment.

"Taking the other estimates as approximately correct, this would leave a possible surplus production of American plates amounting in a good year to about 1,000,000 boxes. But it is not unlikely that the figures given for the consumption that must for some time remain out of reach of the home manufacturers are rather above the mark. So far as they relate to the proportion of imported plates used in the oil and packing, or canning, industries and re-exported, with the benefit of rebate of duty, in the form of cans, the estimate appears to be too high. Inquiry among leading tin plate importing houses, and consultation with one of the best informed individuals in regard to the oil and canning trades, lead us to the conclusion that, at the outside, not more than 1,500,000 boxes of tin plates are re-exported yearly, including the greater part of the tin used on the Pacific coast. This latter amount, which has been figured at between 500,000 and 1,000,000 boxes, cannot much exceed the lower figure. The imports at San Francisco last year—1894—according to the custom house returns of that port, were only 213,000 boxes.

"Moreover, the estimate of 6,000,000 boxes total consumption of tin plates in the United States in a good year appears to be a decidedly low one. The record of tin plate imports for the past ten years show that in the years 1889, 1890 and 1891 the number of boxes of tin plate brought into this country, calculated on a 14 by 20 full weight basis, were 6,783,840 boxes, 6,362,160 boxes, and 6,502,900 boxes respectively. Last year—1894, which was an exceptionally bad one for the tin plate trade—the imports reached 4,537,580 boxes, to which must be added about 1,200,000 boxes manufactured at home, making about 5,700,000 boxes for consumption during a period of unusual trade depression. As very small stocks were held at the close of the year, we should place a good year's consumption at nearer 7,000,000 than 6,000,000 boxes. Calculating on this basis, the over-production claimed in the estimates under discussion would be eliminated, and a sufficiency of trade would be left for all the American manufacturers, provided—and here comes the difficulty—they are at the time producing the material called for by American consumers in proper quantities and proportions. While we do not believe that the American tin plate works will be turning out a surplus of high-grade bright charcoal plates or even of ordinary coke tins by the close of this year—1895—there does seem to be some danger of their overdoing the roofing plate business. According to the latest published returns, the terne plate output of the United States comprised nearly 45 per cent. of the whole, a proportion which, if continuously maintained, would shortly entail a large surplus production of this class of plate. But the good sense and sound judgment of the American manufacturers may be relied upon to avoid any such unwise proceeding."

In February last, Mr. John Jarrett, secretary of the Tinned Plate Manufacturers' Association of the United States, sent out a circular letter to the manufacturers, and also to those who were contemplating going into the business, and from the information thus obtained he prepared a list showing the number of tin mills, or black plate mills as they are generally called in the United States, and their capacities. This list, as furnished to me with subsequent corrections, shows 35 manufacturers with 177 mills completed or in course of construction, and 58 mills contemplated. On this basis the following estimate is made:

	Boxes per annum.
Capacity of mills completed and in course of construction, at 30,000 boxes per mill per annum..........	5,810,000
Capacity of prospective mills.......	1,740,000
Total capacity........	7,050,000
Total consumption of tin plates in the United States, per annum, about..................................	6,000,000
Deduct supply for Pacific Coast, dressed meats and fish, and for Standard Oil Company, imported plates for export on which drawback of duty is allowed, about....	1,500,000
Net market for consumption of domestic plates.............	4,500,000

Mr. Jarrett says in a communication to me:

"The tin plate clause of the McKinley bill went into effect on July 1, 1891. In a period of less than four years the American tin plate industry has so developed as to more than meet the requirements of the home market. Such growth is unparalleled. No other industry, even with the stimulus of the highest protective duties, has ever made such progress in the same period of time. The industry has now reached a point that calls for the closest investigation on the part of those who meditate going into the business of tin plate manufacture, and closer relationship and affiliation between those already in the business.

"It may be interesting to all concerned to know that the tin plate works of England and Wales have an aggregate of 519 mills. Of this number 232 were idle during the year 1894. The outlook for the tin plate industry is not the most promising."

In discussing the above mentioned report by Mr. Jarrett, the Bulletin of the Iron and Steel Association takes the view that the domestic consumption is underestimated, being more nearly 6,770,000 per annum for a period of eight years, while at the same time the fact should be taken into account that many of the prospective works may not be built. It, therefore, considers that it is yet too soon to assume that the capacity is approaching the consumption, but concedes that if America is always to obtain from abroad the plate that is to be exported, because under the drawback provision of the tariff this plate can be imported practically free, then the capacity of production is already near the actual home consumption. But, it adds, why assume that tin plates for export purposes will continue to be made abroad?

In February, 1895, the Iron Age published a statement estimating that 196 hot mills would be in operation by October, and stating that at the low estimate of two tons to the turn, or six tons per mill per day, the output would be 1,176 gross tons of black plate per day, or 317,520 tons per year of 270 working days. As a box of I C plates, 14 in. by 20 in., weighs 112 lb., this means an output of 6,350,400 boxes per annum. The total annual consumption of the United States has been estimated at 6,000,000 boxes, and deducting 1,700,000 boxes for export, for which there is drawback of the duty, there is a net annual consumption of 4,650,400 boxes, so even with a greater consumption and smaller production than above estimated, the production seems liable to exceed the demand. This means that only the best equipped and most economically operated works will be able to meet the consequent severe competition. From this it is figured out that the smaller concerns, which buy their black plates in the open market and depend altogether upon their profits from tinning them, will have a hard struggle for existence, and may be crowded out of existence altogether—as some have been crowded by adverse legislation as already noted—unless they make a specialty of certain high grades of plates, or are particularly favored by good location or equipment. On the other hand, it is estimated that the supply will not so greatly exceed the demand; and that only in the roofing plate line, which is already being overdone, will there be such cutthroat competition.

I have purposely cited these various estimates and discussions in order to show that the general evidence is to the effect that the supply is certainly within sight of reaching the existing home demand. The estimates, however, include the prospective mills, and I, therefore, close this present paper with a statement as to the actual operating capacity. The number of hot mills completed in actual operation at the end of March was 108, each having a capacity of 30,000 boxes per year—or say, 3,240,000 boxes in all—on a production of two tons for each shift, working forty-five weeks in the year. Two tons is a low estimate of the output for each shift, as at some works the gangs are actually turning out an average of over 2½ tons and at some works the average is actually over 2½ tons per shift.

These 108 mills in operation find employment in all departments for from 7,000 to 8,000 men. The total number that will have employment in the operation of the 177 mills and in all other departments—from the billet in some mills and the bar in others to the finished product—will be from 11,000 to 12,000 men.

(To be continued.)

THE TEXTILE INDUSTRIES OF GERMANY.

THE woolen industry in Germany has been highly developed for some centuries. Its principal production was originally cloth, for which the home-grown wool formed an excellent material. The woolen manufacture of Rhenish Prussia, which holds the chief position, had already attained considerable importance in the twelfth century, and even then exported its products. A little later, this industry extended to Brandenburg, Saxony and Lusatia, and reached there, also, in a high state of perfection. According to a recent German trade review, among the woolen productions of the country are particularly to be mentioned cloth, buckskins, and material for men's suits and overcoats, as well as for ladies' mantles in all the various kinds and qualities demanded by fashion. The principal centers of the industry are the towns of Aix-la-Chapelle, Duren, Eupen, Lennep, etc., in Rhenish Prussia, as well as the provinces of Brandenburg, Silesia, Saxony, Lusatia, with numerous places, excelling in their own particular productions, among which are to be mentioned Berlin, Cottbus, Spremberg, Schweibus, Forst, Sagan, Sprottau, Sommerfeld, etc. In addition, the manufacture of dress material, partly of pure wool, partly of wool unmixed with cotton, is of great importance. The centers of this industry are Saxony, Silesia, Rhenish Prussia and Alsatia. Gera and Greiz have not only preserved their old renown in the production of merinos and cashmere, but manufacture combed wool materials, in excellent qualities, for ladies' and gentlemen's garments, which are exported to all parts of the world. For colored woolen dress goods, Alsace, with a highly developed industry, which occupies a leading position, is deserving of mention. For materials for furniture, Chemnitz and Elberfeld are renowned. The manufacture of plush is carried on in Rhenish Prussia and Westphalia, Elberfeld, Viersen, Mulheim-on-the-Rhine, and Bielefeld. The shawl industry has its principal seat in Berlin and the Bavarian Voigland. The carpet industry boasts of a high development, and produces Brussels, velvet pile tapestry and Axminster qualities. Of considerable importance is the manufacture of Oriental carpets in knotted work, which are made in excellent qualities and patterns, and are largely exported. The number of spindles in use for combed wool is estimated at 1,600,000 and for carded wool at 200,000. The German cotton industry is highly developed. Germany possesses about 3,500,000 spindles. Plain cotton tissues, such as calico shirtings, etc., are principally manufactured in Bavaria, Alsace and Silesia. For cotton velvets and velveteens, Linden, near Hanover, Eltlingen (Baden), and Berlin are renowned, these places producing articles that may classed among the finest of the Continent. The weaving of the colored goods, which includes articles for men's and women's clothing, is most flourishing. Alsace, Rhenish Prussia and Westphalia as well as numerous districts in Bavaria, Wurtemburg, Saxony and Silesia, are important centers of this industry. The manufacture of nansook, muslin, flannelettes, piques, sateen, colored stuffs for tablecloths, bed covers, dressers, etc., is very important. In Alsace, Silesia and Bavaria bleaching and dressing are important industries. Printing is one of the most important branches of the German collar trade. The linen industry is of great antiquity. Favored by an extensive cultivation of flax, it not only supplies the wants of the country, but exports large quantities of thread and linen to other countries. In spinning, the spinning jenny has almost entirely supplanted the spinning wheel, and the mechanical loom is coming more and more into use, although the hand loom still forms an important factor in this branch. The principal districts of the linen production are Silesia, Westphalia, Saxony, Bavaria and Wurtemburg. Silesia has numerous branches of the linen industry, which are carried on both by machine and hand looms. The manufactures of Bielefeld are of great repute. The manufacture of underlinen is carried on extensively, more especially in Berlin and Bielefeld. It produces ready made shirts, collars and cuffs, and exports largely. The jute trade has greatly prospered during the last ten years, and has in use about 76,700 ordinary spindles, 2,000 thread spindles, and 3,600 machine looms. The German silk trade has its center in Rhenish Prussia, particularly in the district of Crefeld, and its productions are well known in all parts of the globe. The most varied fabrics are produced, black and colored materials of the heaviest qualities for dresses, as well as the thinnest for linings; fancy trimmings, in pure and mixed silks; sateens, materials for umbrellas, cravats, and clerical vestments, plush black and colored piece velvets and ribbons. In most of its products, Crefeld holds the first position. Of late the machine loom has been used more and more in this trade. Besides Crefeld, the silk and velvet trades are established in Elberfeld, Viersen, Gladbach, Mulheim-on-Rhine, Bielefeld, as well as in Freiburg, in Baden, and in Upper Alsace. Hosiery is of great importance in Germany, and large quantities are exported. The chief places for this trade are Saxony, with Chemnitz as the center of a great trade, as well as Middle Franconia, in Bavaria, and the district of the Black Forest in Wurtemburg. The manufacture is carried on in large separate establishments, which are equipped with the latest machinery. The trimming industry is brought to a great perfection, and excels as well in staple goods as in novelties. Barmen enjoys a great reputation for its ribbons, cords, laces, galloons, and other articles, while trimming for ladies' dresses, etc., are made in accordance with the changes of fashion in Berlin, Annaberg, Buchholtz, and other places. The lace industry has more especially its seat in Saxony, where it forms an important occupation of the women of the country, and produces the various descriptions demanded by fashion. The different kinds of lace made are Mantilly, Mechlin guipure and Valenciennes. In addition, there are made from cotton, as well as silks, capes, pellerines, parasol covers, veils and similar articles. Machine made lace and embroidery are principally

made in Plauen, and are largely exported. The manufacture of curtains is carried on to a large extent.—Jour. Soc. of Arts.

THE ORNAMENTAL IRON INDUSTRY.

THE wrought iron from which most of the ornamental and artistic work made here, such as gates, fences, lamps, window grills, etc., are manufactured, comes from Norway. Artistic wrought iron work first came into general use in Italy in the thirteenth and fourteenth centuries in the form of screens, tombs and grills for windows. Among the finest examples of this sort of work are the screens around the tombs of the Scala family at Verona. They consist of a sort of network of light cusped quatrefoils each filled up with a small ladder (scala) in allusion to the name of the family. The English workers in wrought iron at that period were also especially skillful.

The grill over the tomb of Queen Eleanor at Westminster, by Thomas de Leghton, is a remarkable example of skill in welding and modeling with the hammer. The material is brought to this country in flat, square and round bars ranging from 8 to 9 feet in length and from $\frac{1}{8}$ to $2\frac{1}{2}$ inches in width and thickness. The material in its hot plastic state can be formed and modeled under the hammer to almost any degree of refinement, while its great strength allows it to be beaten out into leaves and ornaments of almost paper-like thinness and delicacy.

With repeated hammering, drawing out and annealing it gains much in strength and toughness. In manufacturing leaves, a pattern of each, if of different designs, is first drawn out on paper. Two or more strips or pieces of wrought iron are then heated in a forge and welded and beaten out by the attendants on an anvil into a thin sheet the proper size and thickness. The top edges are generally beaten out thinner than the bottom, it being necessary to have the bottom edge thick so that there will be enough material to weld the end to another piece. The sheets of wrought iron are hammered out to from $\frac{1}{8}$ to $\frac{1}{16}$ of an inch in thickness.

The pattern of the leaf is laid on the metal sheet, the operator drawing a pencil around the edge, leaving the outline on the surface. The sheet is then placed on an anvil and the pattern cut out by hand with a number of different shaped steel tools or chisels. The flat leaf is then placed on a lead block and ribbed.

This is performed by means of a hammer and dull chisels, the stroke of the operator's hammer pressing the metal into the lead block, forming the rib without breaking the material. These ribs range in depth from $\frac{1}{4}$ to $\frac{1}{16}$ of an inch in depth. The leaf is then hammered into its proper shape over a circular shaped tool. The instrument, which has a rounded face, is fastened securely in a vise; the operator, by tapping the leaf lightly with a long, thin, circular hammer, causes it to curl and form itself over the tool into its proper shape.

If long hammering is required to give the leaf its proper form, it becomes necessary to anneal it several times to prevent the material from crystallizing and breaking.

In twisting iron for posts, etc., the material is heated red hot and fastened horizontally in a vise. If the work is large, the twister or operator uses a wrench which is placed over the end of the bar. A half turn is given by the operator at every twist. To prevent the material from getting narrower during the operation, it is necessary for an experienced person to cool the work with water at each twist, the cooling process preventing the twists from moving after each has been completed. On some large work the operation of twisting requires the labor of four or five men.

Small work is performed by turning the metal by the hands with a cloth, the cooling process being done in the same manner as the large work. Curled iron wire is formed by means of a hammer and a pair of round pointed tongs. The circular wire is first heated red hot, the end being placed in a hole in the top of an anvil. The operator, by turning the hot wire around with the tongs, and at the same time tapping the wire lightly against it with the hammer, causes the material to curl and become oval or egg shaped. Scrolls are formed or bent in a circular iron gage or form.

The iron bar is first heated red hot. The operator then bends a hook into the end of the bar with a hammer. This hook is fastened into a similar one in the center of the gage and the bar is then bent and hammered in and around the form. When the scroll is formed it is taken out of the gage and cut off, the operation being repeated until the bar is used up. The scrolls, if to be doubled, are then reheated, the ends being placed back to back and welded together.

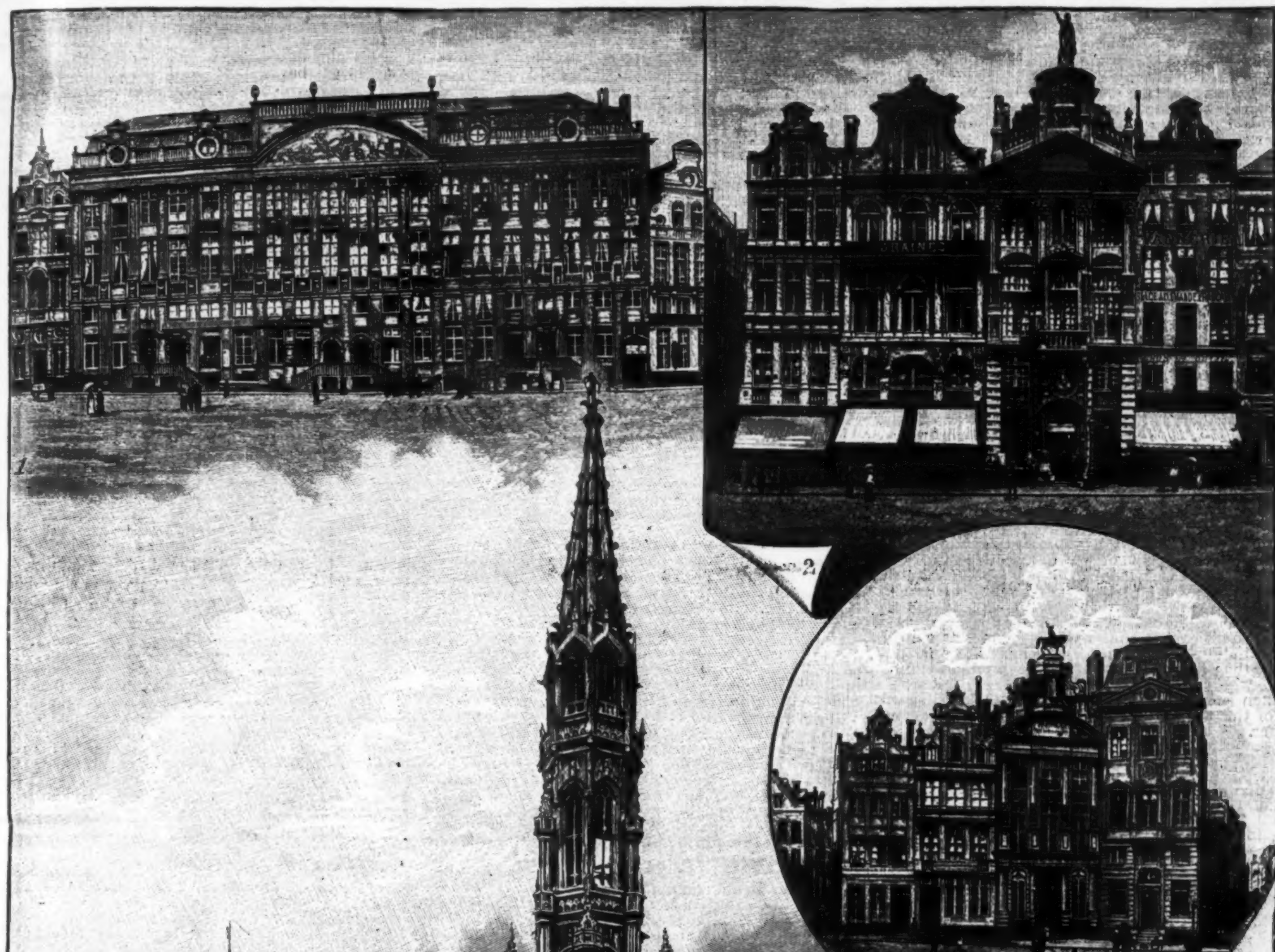
The ends or edges of some of the work require grinding, the operation being performed by means of a 12 inch emery wheel traveling at the rate of about 2,800 revolutions per minute. A first-class ornamental gate, about 4 feet in width and 7 feet in height, will contain about from 600 to 700 running feet of wrought iron.

To build such a gate it would require the labor of six men about six weeks, every part being welded to each other. The value of the gate when completed would be about $900. The sketches were taken from the plant of Bayer & Scherbner, New York City.

THE ORNAMENTAL IRON INDUSTRY.

PUBLIC BUILDINGS IN BRUSSELS.

BRUSSELS, the capital of Belgium, is situated on the small river Senne, about fifty miles from the sea, in the midst of a beautiful and fertile country. It is picturesquely built on the top and sides of a hill. Brussels may be considered as consisting of two distinct parts, the New Town, or upper part of the city, which is dry and healthy, and contains a large number of handsome buildings, both public and private. The Lower Town is more interesting of the two, but is low, and unhealthy in summer. The principal point of interest in the Lower Town is undoubtedly the Grande Place, before the Hotel de Ville. We present some views of this interesting square, for which we are indebted to Ueber Land und Meer. The Grande Place, or market place, is 120 yards long and 74 yards wide, and is bounded by the Hotel de Ville and several old guild houses. It is one of the finest mediæval squares in existence and presents a marked contrast to the otherwise modern character of the city. It occupies an important place in the annals of Belgium, for in 1568 twenty-five nobles of the Netherlands were beheaded here by order of the



1. House of Corporations. 2. Guild Houses, opposite the old State House. 3. Guild Houses. 4. Old State House, now the Hôtel de Ville.

PUBLIC BUILDINGS IN BRUSSELS.

Duke of Alva, the most distinguished victims being Lamoral, Count Egmont and Philip de Montmorency, Count Hoorn. The Hotel de Ville (Fig. 4) or old State House, is by far the most interesting building in Brussels, and one of the noblest buildings in Belgium, a country where particular attention is given to civic architecture. It is of irregular form, being 66 yards in length and 55 yards in depth; the principal façade toward the market place is in the Gothic style. The eastern half was begun in 1402. The tower is 370 feet in height, but for some unexplained reason does not rise from the center of the building. It was completed in 1454. The facade has recently been elaborately restored. The open spire, which was damaged by lightning in 1863, terminates in the gilded metal figure of the Archangel Michael. It serves as a vane, and is 16 feet in height. In the court of the Hotel de Ville are two fountains of the eighteenth century. The interior is very fine, many of the rooms being decorated with carved oak, tapestries and paintings. The view from the tower commands an admirable survey of the city and environs. To the south the Lion Monument on the field of Waterloo is distinctly visible in clear weather. Opposite the Hotel de Ville is the Halle au Pain, better known as the Maison de Roi, formerly the seat of the government authorities. The building was erected in 1514–25 and was rebuilt in 1877–84. It was fitted up for the municipal authorities and joined with the Hotel de Ville by a subterranean passage. Counts Egmont and Hoorn passed the night previous to their execution here, and are said to have been conveyed directly from the balcony to the fatal block by means of the scaffolding in order to prevent the possibility of a rescue by the populace. The guild houses in the Grande Place, shown in Figs. 2 and 3, are particularly interesting. They were re-erected at the beginning of the last century, after having been seriously damaged by the bombardment of Louis XIV, in 1695. The old hall of the Guild of the Butchers, on the south side, is indicated by a swan. The Hotel des Brasseurs, recently restored with considerable taste, bears on its gable an equestrian statue of Duke Charles of Lorraine. On the west side is the Maison de la Louve, or Hall of the Archers, which derives its name from the group representing Romulus and Remus. To the left of the Louve is the Hall of the Skippers, the gable of which resembles the stern of a large vessel with four protruding cannon. To the right of the Louve is the Hall of the Carpenters, 1697, richly adorned with gilding. On the west side, to the right of the Halle au Pain, is the Taupe, or Halls of Tailors, built in 1697, and recently restored. The extensive building occupying almost the entire southeast side of the square was formerly the public weighing house.

Taken as a whole, this square, with its buildings, is one of the most interesting sights which Belgium has to offer.

SULPHUR IN OILS.

By WILLIAM FOX and D. G. RIDDICK.

THE following table gives the mean amounts of sulphur in grains per gallon (by weight) that we have obtained from various oils by burning them by means of a floating wick, such as is used for night lights, and condensing the vapors given off in a sulphur apparatus in the same way as sulphur is determined in coal gas. Those oils which do not burn alone were mixed with a sufficient quantity of sperm or cocoa nut oil to make them do so without smoking:

Name of oil.	Sulphur.
Pure brown rape	14·2
Ordinary brown rape	17·4
Refined brown rape, with sulphuric acid	16·8
Refined brown rape, with fuller's earth.	10·0
Ravison rape	19·1
Jamba rape*	113·0
Linseed, La Plata	trace
Sperm, pure	2·3
Sperm, bottlenose	3·1
Cottonseed	trace
Cocoa nut, ordinary	3·7
Ground nut	none
Neat's foot	4·7
Olive	none
Cod	5·8
Russian mineral, 0·908	20·5
Russian burning mineral	10·3
American burning mineral	16·3
American burning water white mineral	8·1
American burning safety mineral	14·0
Scotch mineral for gas making	49·8

—Chem. News.

CITRIC ACID FROM CANE SUGAR.

By Dr. T. L. PHIPSON.

I HAVE recently made an experiment at the Casa Mia Laboratory, Putney, which is perhaps worth recording. I have found that an acid, which can be no other than citric acid, is produced in notable quantity by the action of permanganic acid on a solution of sugar in the cold.

Some few grammes of cane sugar are dissolved in water to which a few drops of sulphuric acid have been added, and a rather strong solution of potassium permanganate is poured in. In a short time, at summer temperature, the solution is white and transparent like water. It is neutralized by addition of a little ammonia, and solution of calcium chloride added. No precipitate occurs, which shows the absence of tartaric and oxalic acids, but on boiling the liquid a precipitate occurs which is soluble in acetic acid, and these reactions are characteristic of citric acid. The precipitate being collected and decomposed with sulphuric acid, gave a solution which, on being evaporated, gave small but well formed crystals, which corresponded in form and properties with those of pure citric acid.

If large quantities of permanganate are used, then a notable amount of oxalic acid is produced at the same time.

The Casa Mia Laboratory, Putney, London, June 17, 1895.

* Benedikt and Lewkowitsch ("Oils, Fats, Waxes") state that Jamba oil is free from sulphur.

THE CAUSE OF ASPHALT OR PARAFFIN BASE IN PETROLEUM OILS.

WHY should one petroleum oil have a paraffin base and another an asphalt base, while the third contains both paraffin and asphalt?

Petroleum oil consists principally of the members of the methane series of the hydrocarbons (C_nH_{2n+2}) extending from methane to paraffin, and partly of the ethylene series (C_nH_{2n}).

By destructive distillation the above named hydrocarbons can be obtained from coal, bituminous and carbonaceous shale, cannel, lignite, and peat, and from other organic matter.

From testimony that has been presented by different authorities, it must be conceded that, through chemical and mechanical heat, petroleum oils are distilled in nature from carbonaceous substances contained in shales and other rocks.

During destructive distillation in Nature's stills and laboratories, as well as those constructed by man, the following chemical phenomena can and probably do take place, producing paraffin and asphalt:

Paraffin, when pure, has a specific gravity varying from 0·8236 to 0·940, having a melting point from 16° to 80° C. It contains C 85·7 H 14·3.

Paraffin can be prepared from coal, bituminous and carbonaceous shale, on the condition that a very low heat is employed.

Paraffin begins to decompose when exposed to a temperature exceeding 140° C. When submitted to dry distillation, a portion of the paraffin is decomposed into liquid hydrocarbons.

Sulphur dissolves in petroleum and retards its ebullition; consequently, when an attempt is made to distill a mixture of them, it can succeed only at a much higher temperature than that which is usually necessary to convert pure petroleum into vapor. The introduction of sulphur into a petroleum oil, boiling at 140°–150° C., may retard its boiling point as far as 180°–200° C., according as it may exist in it in greater or less quantity. This action is not confined to the liquid hydrocarbons; it applies also to all the asphalts without exception, assuming as essential a state of absolute purity.

Sulphur decomposes paraffin wax, the kind of paraffin most easily thus attacked. Carbonaceous shales, containing 10 to 20 per cent. of sulphur, yield scarcely any paraffin. When heated with sulphur, paraffin wax is decomposed, sulphureted hydrogen being evolved and carbon deposited.

Ozocerite in a fossil state is known as earth wax, or ozocerite. It is a solid bitumen. In its native state it is of yellow color, light specific gravity, and inflammable. When refined, it is a beautiful, white, crystalline body, having the properties of paraffin wax.

Judging from the above described chemical reactions, ozocerite must be the product of a distillation of carbonaceous material at a low temperature, in a geological formation nearly free from sulphur. There must also be these conditions attending the distillation of petroleum oils where they are rich in paraffin wax.

In geological formations where sulphur is abundant, the temperature during distillation would be sufficient to decompose paraffin wax, producing only the lighter members of the methane series.

Paraffins do not contain sulphur or oxygen.

When heated in a current of oxygen, petroleum oil undergoes a quick change, and turns into petrolene, one of the chief principles of asphalt. Petrolene is composed of carbon, hydrogen, and oxygen.

Although not an essential element of petrolene, sulphur is always found in natural asphalts chemically combined.

Asphaltene is not, and cannot be, a product of distillation. It is petrolene oxidized to a greater extent by atmospheric or other oxidizing influences, subsequent to the distillation or production of petrolene from a carbonaceous substance. In nature, the further petrolene is removed from atmospheric influences, the less the asphaltene.

Metallic peroxidized bases have little effect when cold on petroleum, but decompose them quickly at their point of ebullition. In this latter case some of them produce in the petroleum oils a lively reaction, which may even reach the point of setting them on fire. Others acidify the oils and partly dissolve in them. There is always a return of the base to a state of lower oxidation; a disengagement of water and the formation of petrolene of the asphalts, which colors more or less the changed oils.

For example, the bioxide of copper, heated in contact with a certain quantity of white oil, causes it to assume an acid character. It is dissolved in it and imparts to it a greenish color. The red oxide of lead behaves in the same manner, except that the liquid assumes a red tint. The peroxide of manganese, under the same circumstances, oxidizes it energetically. A portion of the oil distills of itself, while the rest is converted to petrolene.

The peroxides of heavy metals decompose asphalt under the effects of a high temperature into water and carbon.

Asphaltum is composed of carbon, hydrogen, and oxygen, in uncertain amounts, as follows:

Carbon	76–87
Hydrogen	6–13
Oxygen	2–10
Sulphur	0–10

It contains three principles, retene, petrolene, and asphaltene, which can be separated by solvents.

When carbonaceous material is distilled in geological formations in which there exist metallic peroxidized bases and other oxidized bodies, or in which oxygen is liberated by chemical reactions, petrolene of the asphalts is formed. As the petrolene approaches the atmosphere, it is gradually oxidized so as to form asphaltene.

A. S. COOPER.

Santa Barbara, June 25, 1895.

POROSITY OF SOLID BODIES FOR THE LIGHT ETHER.

ZEHNDER describes an interference apparatus by means of which he has endeavored to detect movements of the ether in connection with movements of surrounding bodies. The work was undertaken to test the following hypotheses of Fizeau, that either the ether adheres to the molecules of bodies and shares their movements; or that it is free and is not influenced by such movements; or that only a portion of the ether is free and that another portion is bound to the molecules of bodies and moves with them. Zehnder's apparatus consisted of an air-tight receptacle connected with long tubes through which light can be sent and suitably refracted and reflected in order to produce interference bands. By means of a moving piston the air in the tube can be set in motion and a change in the interference bands can be noted. Afterward the entire apparatus is exhausted of air and again the piston is moved in order to set the ether in movement. No change, however, could be observed in the latter case, and Zehnder remarks upon the limits of porosity of iron for the light ether. Michelson's experiments on the relative motion of the ether and the earth's atmosphere are commented upon and are repeated with similar negative results. The author concludes that the relative motion between the earth and the enveloping ether, at the observing station in Freiberg, did not attain the value of the 800th part of the velocity of the earth in its path.—Ann. der Physik und Chemie, 1895, No. 5, pp. 65–81.

HOLIGARNA AND ITS BLISTERING PRINCIPLE.

By DAVID HOOPER, F.L.S., Quinologist to the Government of Madras.

ALL observant forest officers in India have noticed at different times the remarkably caustic nature of the black secretion that exudes in the dry weather from various species of Holigarna. The tree is called in Malabar the black varnish tree, in contradistinction to the yellow varnish tree, or Garcinia, which yields the gum resin known as gamboge. The black varnish is used for waterproofing boats, furniture, and houses, and for indelibly fixing black figured patterns on linen and cotton cloths. There are other natural black varnishes obtained from anacardiaceous trees growing in Burma, China, Japan, and Ceylon, and the exact character of their exudations would form the subject of an interesting research, but the present article endeavors to show the nature of the vesicating principle separated from a hitherto unexamined Indian genus.

Alluding to Holigarna longifolia, Roxb., Colonel Beddome describes it as a common tree about the Western Ghauts of the Madras Presidency, from Canara to Cape Comorin, which yields a very black, acrid juice from the trunk and rind of the fruit. This is used by painters as a varnish. Mr. Gamble, in describing this large tree, says: "It gives a black, acrid exudation, which raises blisters and is much dreaded by the hill people." Mr. Bourdillon, Conservator of Forests for Travancore, says of it: "The whole tree, leaves, bark, and fruit, secrete a very poisonous black juice, which raises blisters when it falls on the body. It affects some people and not others." The fruit is referred to by some writers as a medicinal agent, but its action, and the uses for which it is employed, are not stated.

There are seven known species of Holigarna, all of which are Indian. Their names and geographical distribution are thus recorded in the "Flora of British India":

H. arnottiana, Hook., Western Peninsula.
H. ferruginea, Marchand, Western Peninsula, Travancore.
H. longifolia, Roxb., Chittagong, Pegu.
H. helferi, Hook., Tenasserim.
H. grahamii, Hook., Western Peninsula.
H. beddomei, Hook., Western Peninsula.
H. albicans, Hook., Pegu, Martaban.

The native names applied to these trees are charei, karun-charei, cattu-tsjeru (Malyalum); kalu-geri, kuti-geri, hool-geri (Canarese), bibu (Mahratta). Mr. Bourdillon forwarded some specimens of the fruits of Holigarna ferruginea for examination. The exudation from the stem has blistering properties, but this can only be obtained in the dry weather, about March and April.

The fruit is a drupe, ovoid or elliptic in shape, black colored, about seven-eighths of an inch long by half an inch in diameter. The pulpy pericarp becomes thin when dry, and is of a uniform black color, but the pulp when fresh is greenish and mucilaginous. The testa is thin and dark brown, and incloses a whitish starchy pair of plano-convex cotyledons, with dark colored veins running through them. The embryo is suspended from below the apex of the fruit, and the minute radicle is situated next to the hilum.

The aqueous soluble extract of the pericarps consisted of mucilage, with a small quantity of a tannic acid giving a green color with ferric chloride. The ether and alcohol extracts of the pericarp contained the active vesicating principle of the fruit, associated with the black resinous substance forming the varnish. This principle was separated from the resins by adopting the process devised by Staedeler in examining the acrid principle of the cashew fruit. An ethereal tincture was made of the bruised pericarps, and the ether was allowed to evaporate without heat. The residue was dissolved in alcohol and treated with some freshly precipitated oxide of lead. The gray precipitate was collected on a filter, and after washing was digested in some ammonium sulphide solution. The lead sulphide was filtered off, and the filtrate was treated with dilute sulphuric acid, which separated a small quantity of oily substance. This melted at 26° and was recognized as anacardic acid. The filtrate from the gray precipitate was carefully evaporated at a low temperature, and left a yellowish colored oily residue, which had a most irritating and acrid taste when applied in a most minute quantity to the tongue, and produced a redness and soreness when rubbed on the arm. It is evident, then, that the fruit contained a body very much allied to, if not identical with, cardol, and that the constituents are very similar to those found in the marking nut.

The seeds when dry had a peculiar odor of Ceratonia pods. They contained gallic acid, 12·4 per cent. of tannic acid, 8·5 per cent. of fat, and 3·7 per cent. of mineral matter. A section of the seeds touched with a drop of caustic soda turned the color of the anastomosing veins into a bright blue, and formed a pretty

object under the microscope. The alcoholic solutions of both pericarp and seeds gave a greenish color with caustic alkalies; no doubt the principle giving this color was contaminated with other substances which afforded red tints with soda, for when separated from the tannin it gave a blue color. Basiner in 1881 found that the oil from the pericarps of the marking nut tree gave a green color with potash, and Dr. Lyon in his "Medical Jurisprudence for India" relies upon this test in detecting the presence of the marking nut in toxicological investigations. As will be seen above, Basiner's test for the marking nut would show the same result if applied to similar preparations of Holigarna.

It is interesting to notice that the properties of the Holigarnas are similar to those of two other trees of the same natural order, namely, the marking nut (Semecarpus anacardium, L.) and the cashew nut tree (Anacardium occidentale, L.), and from recent investigations by Dr. Pfaff on Rhus toxicodendron and Rhus venenata it is not at all improbable that cardol is present in other vegetable products of the Anacardiaceæ. —Pharm. Jour.

DON MANUEL CANDAMO.

THIS statesman of Peru was, a short time ago, President of the Provisional Government. He began his political career in 1886, as President of the National Committee of the Constitutional Party which elected General Caceres. Mr. Candamo was in Parliament for ten years and always showed ability, rectitude and

DON MANUEL CANDAMO, PRESIDENT OF THE PROVISIONAL GOVERNMENT OF PERU.

independence. On account of these qualities the Senate chose him for its chairman.

Mr. Candamo will succeed Mr. Piérola.

THE LONG GAINS OF SHORTHAND.

By AMOS R. WELLS.

I WAS once greatly impressed by the following simple incident. A lady was returning to an important mission field in Spain, and a friend of mine inquired her future address, at the same time taking out his tablet to write it down. Jokingly she rattled off the address in Spanish, prolonging it unduly, and repeating it as rapidly as possible. "Now," asked she, "shall I spell it?" "No," answered my friend, dryly, "I have it." He was a shorthand writer.

Now that I myself have become in a measure proficient in the beautiful art, I can afford similar surprise to my friends by accomplishing large pieces of work in very short times. The secret is that I am my own stenographer. Wherever I go, on the cars, waiting in railway stations or on doorsteps, pausing in my "constitutionals" for a mere whiff of time, at my desk in the city, at home in the suburbs—everywhere I am my own stenographer and dictate to myself. My typewriter transcribes my notes as readily as her own, writing the same system; and I most emphatically commend this plan to all writers, teachers, editors, lawyers and clergymen that wish—and who does not and should not?—to accomplish their arduous tasks most easily and speedily.

For "to save time is to lengthen life." That motto is fittingly chosen by a prominent system of stenography. And to save nerves is to save time and life together.

And what is more nerve-racking than this whirling at pen point through miles and miles of wearisome space, making as in that word "making," twenty-five strokes, when shorthand would write it far more legibly and unmistakably in three! From writer's cramp to nervous prostration, a long series of distressing maladies is attributable to this decrepit heirloom from primitive ages that we set up and worship in our schoolrooms, this system of writing, so tedious that it drags the pen a ten-mile circuit to reach a result one mile away, so inaccurate that in rapid writing it is quite impossible to decipher half the letters save by the context, and so unscientific that letters pronounced in similar fashion are written quite differently, while letters of the greatest diversity, like i and r, c and e, n and u, are written in almost the same way.

There will come a time (may it be in my day!) when shorthand will be taught in all schools and become the universal medium for correspondence, and, for aught I know, for printing. Its advantages are so many and manifest that long ago our Yankee nation would have adopted it were it not for an inconsistent veneration for what has no other recommendation than its antiquity, and an ill-founded but almost universal impression of the difficulty of learning shorthand.

For the latter "David Copperfield" is largely responsible. Dickens has drawn in that novel a picture of the impregnable fortress of shorthand that would daunt the soul of the boldest knight. But Dickens might have told us what a difference there is between the shorthand that can report verbatim a rapid speaker and the modicum of skill necessary to "dictate to one's self." Expert reporter though Dickens was, we all know that it was in this latter capacity that shorthand helped him so valiantly all through his splendid toil.

And the gaining of enough shorthand to quadruple the speed and ease of any writer is a matter of ready accomplishment. A dot on the line for "a" and a dot above it for "the"—you can calculate how many strokes you have already saved yourself in a day's writing. A short oblique stroke above the line for "of" and on the line for "to"—and you have another immense economy. Step by step, as you learn shorthand, you can put it to use in your writing, to your immediate and vast relief. The principles are so simple that any ordinary child could learn them, so scientific as to delight the mature mind. The forms of the words are beautiful enough to please the artist, practical enough to please the man of business. No teacher is needed, and the odd minutes will suffice for its mastery for private use. If you need it you can have it, and ought to have it.

Of course, you are confused by the rival claims of the different systems. Shorthand, like temperance, would long ago have won the world, could its advocates have united on a method. But never mind. There are many systems, any one of which will do your work. A friend of mine has adopted one of the most illogical, clumsy, absurd styles of writing imaginable—to be shorthand at all—and produces results so accurate and swift that all objectors are instantly silenced. It is, however, of the utmost utility to be able to hand over your notes to your typewriter for her to transcribe; and so I advise you to adopt one of the three admirable systems in widest use—Graham's, Pitman's or Munson's. I swing my own particular hat for the first named.

If you will get a full series of books—handbook, reader and dictionary; if you will persistently introduce the forms, as you learn them, into your ordinary writing; if you will practice reading your shorthand as vigorously as writing it, and if you will constantly consult the shorthand dictionary to avoid learning forms that are not the best, you will soon win a happy emancipation from the labyrinth of longhand.

Then you will be able to make complete memoranda while other folks would be scrawling the date. Then you can take down pleasing sentences from lectures and sermons, precisely in the words used by the speaker. Then you can make liberal extracts from useful and helpful books, and carry a small library of these quotations in your vest pocket, if need be. Then, so far as you can persuade your correspondents to use shorthand, you can abridge your letter writing three-fourths. Then you will find you can write on the cars far more easily and legibly than with longhand, being able, as it were, to sandwich in whole words between the jolts. Moreover, your seatmate will not be able to see what you are writing, and you may be analyzing the financial situation or inditing a sonnet to Fulvia's bangs for all he can tell; and this is no slight boon to a bashful poet. Then notes for essays can anywhere be jotted down, outlines of sermons, abstracts of arguments, passages of lectures. Then your private notes may be left around anywhere, in no danger from the curious. And then, as already said, you will have, wherever you go, that crowning luxury of the nineteenth century, a shorthand secretary.

The small space into which writing can be packed in shorthand is no slight advantage. It makes your manuscript easier to store and to carry, and it lessens the paper bill. As the writing is so regular and compact, it is easy to estimate its length. For the same reason it can be read far more rapidly when you are once accustomed to it. You read words and even sentences as a whole, and the meaning dashes at you with all the force and brilliancy of picture writing, yet with the accuracy of letters.

You become quicker, more alert of mind and hand. Shorthand leads to rapid composing. You need no longer hesitate over orthographic enigmas in the midst of an ode. Thought is no longer impeded by pot-hooks. There is a buoyant sense of mastery. You are brain-free.

Revision and rewriting, so necessary to most literary work, are made pleasures by shorthand, while under the serfdom of longhand they are dreaded, and disastrously shunned. We seek to prolong the mechanical task rather than shun it.

For there is a strange fascination about shorthand. We write as easily as we speak—and that, by the way, soon teaches us to speak more accurately—as to our long u's, for instance. We learn to appreciate a thousand beauties of our English language. And the elegance of the shorthand forms themselves furnishes a strong allurement. The most wretched of penmen have become copperplate stenographers.

And when you add to all these advantages this final attraction for the rising young man—that stenography is a good business; that stenographers are always in demand, and are quite likely always to be in demand, unless Wizard Edison shows us how to do it by electricity; then the measure of shorthand's utility and attraction would indeed appear to be full and running over.—The Independent.

THE APPLETON CABINET, AMHERST COLLEGE.

THE quiet way in which the scientific men of Amherst, not only in the college, but also in the State institution, the Agricultural College, which lies a short mile outside of the business center of the town, are doing an excellent quality of work, is worthy of comment. Amherst is a pretty town, and the position of the college buildings, perched as they are on a slight eminence, bounded by the common, with its splendid trees, is as sightly a spot as is to be found in all New England. The town is a little away from the immediate river valley of the Connecticut, being somewhat higher than Northampton (with correspondingly lower temperature in the warm season) and has superb views of the Mount Holyoke range, which limits vision to the south with its many sharp waves as it stretches across the plain.

The locality is interesting in other senses than the picturesque, for much of the geological history of our State is to be gathered from investigation of the rocks and formations in the immediate neighborhood. Much of the story has been ascertained by the patient and persistent investigations of the late President Hitchcock, while the present professor of geology, Benjamin K. Emerson, has carried forward the good work with spirit and energy.

The Appleton Cabinet, a building of the most modest type and one which in magnitude can hardly compare with the immense modern museums, was erected some forty years ago at an expense of ten thousand dollars. But unassuming as the building is, its contents are a surprise and a wonder; so valuable, indeed, that one may hope that the wish of the instructors to have some funds with which to improve it and to some extent to modernize it may soon be realized. Much of the material within the museum was secured by the late President Hitchcock, who was the investigator of the remarkable footprints of the valley and the unfolder of all the important train of research to which they have given rise. It was a new department, ichnology, and one original with Amherst and its skillful president. Within the museum walls are gathered upward of twenty thousand specimens of the "bird tracks," for so they will ever be called, notwithstanding the fact to which our attention is constantly called that the animals which made the tracks were not birds, but reptiles. The rich localities in which these treasures have been found all lie within sight of the tower of the old chapel, a point to which visitors sometimes climb to secure the splendid view.

From Lily Pond ledge to the north, behind the shadow of Mount Toby, have come the finest and best of the slabs, the ledge lying not far from Turner's

Falls, but across the river. A short distance to the north, near the mouth of the Miller's River, another ledge has yielded, though less abundantly, while the sides of Toby and of Tom have given tribute also to the inquisitive spirit of man. The great slabs of rock have yielded little by little the interesting story of the great reptiles that waded here or walked along the shores of the great lake, beasts that lived here ages ago and probably died here, although evidence on that point is limited to a mere handful of bones, which are treasured as the rarest of the rare. What food for thought that a mere footprint in the sand should outlive by millions of years the organism that impressed it!

A visit to the museum under the skillful guidance of Prof. Emerson is a treat indeed, for the choice slabs of stone are made to yield up their hoarded secrets and bits of evidence in the most entertaining way. Here in a case are the trial slabs made by Prof. Hitchcock, who with Yankee ingenuity made artificial slabs of stone materials, exposed them while soft to the influence of the rain and persuaded hens and dogs and barefooted boys to walk over them so that he might be certain from actual experiment just what the results would be. And from this investigation and the careful study of the slabs, great and little, he put together piece by piece the dissected puzzle of the life story of a race of animals of which not one to-day is left, not even in its skeleton.

There is here a most vivid example of the careful thought that is necessary to the geologist before he can read the meaning which is hidden in his specimens. From a few marks on some stone slabs the world can know that great reptiles had their home in the great Connecticut Valley long before it was fit for the abode of man. Here is a foot so perfectly cast in the material that even the wrinkles are preserved. There, a little mark behind the foot, is an indication that the reptile rested a moment, and as it did so its heel came in contact with the sand, and, thoughtless as the action was, it has left its record which will endure to the end of time. Here a little mark means a smaller fore foot, and these odd straight lines running between the feet are the traces of a heavy dragging tail. And mark you, as this little fellow curved in his course, how his tail trace drags out of center, and even passes outside of the limits of his track, just as the platforms of the electrics do to-day as they round some sharp curve.

When one sees things like this and has an interpretation of them furnished him, he begins to realize that the popular conception of a geologist as a man who lives and almost sleeps with his hammer in his hand is far from correct, for the most important and necessary work comes in the laboratory, where he must rack his brains to account for the phenomena which his rocks present to him. The geological hammer is a very convenient and at times necessary instrument, but a single hammer actively at work can easily unearth problems enough to keep a whole corps of geologists busy all the time.

Aside from his regular lectures in the college course, Prof. Emerson has done an enormous amount of work in the consideration of the local geology. The region is exceedingly interesting in many ways. The bed of a great interior lake, it presents many phenomena in connection with the latter, terraces, sand plains, the borders of the old lake and the many traces of extinct animals. The old lake is a very interesting feature. From the piazzas of his home, Prof. Emerson can point out its level, which he has developed. The valley of the Connecticut at this point is wide, and on every hand it is bounded by high hills. To the east the hills of Pelham furnished a barrier to the waters, rising hundreds of feet above the valley and giving us to-day some of the highest villages in the State. To the north the line is continued by Leverett and Shutesbury, towns so high and so hilly that their intercourse with the world even now is by means of the mail stage which makes its daily journey over the hilly roads.

On the west side of the river the hills of Conway, Whateley and Williamsburg mark the inclosing barrier, making with Tom and Holyoke a circular basin some twenty or more miles in diameter, an enlargement of the old Connecticut, which was a stream fully equal in size to the present river, but at a higher elevation, the outlet between Tom and Holyoke having been worn down gradually to its present level. All along the hills which bound this basin may be seen the traces which mark the shore line and height of the old lake, a line known for short as "three, fifty-one" or some kindred figure indicating its height above the sea. Of the minor hills within the valley itself some few of them, like Mount Warner, were islands, the water reaching nearly to their summits, and in connection with such hills there are many evidences of the water's work in long bars which stretch downward over the bed of the lake. The terraces of the Connecticut River itself are full of interest. These show themselves as steep pitches in the road as one crosses a ferry, and one is inclined to wonder whether the poor little horse will be equal to the task of drawing his load up the sudden slopes, but fortunately they are but a score or so of feet in height. Then there are the sandstone cliffs of the Sugar Loaves at Deerfield, a few miles up the valley, remnants of the old red sandstone, which was formerly quite abundant here, and the other mountains, basaltic in their nature, the record of volcanic eruptions of ages ago.

It is an interesting experience to sit for a while with Prof. Emerson in his cozy library, stocked with relics which speak of extended travel, and, map in hand, listen to the story of the geological features of the country. To see how curiously the contacts between the sandstone and the basalt are preserved in the contours of the present mountains and how queerly the different formations wind in curves over the surface of the country.

But Prof. Emerson's work has been by no means confined to the country which centers about his Amherst home. The United States Geological Survey has made use of his skill and experience, and he has been the guiding spirit in the investigation of the geological features for the governmental maps of central and western Massachusetts. The hills of Berkshire, of Franklin County and Hampshire and Hampden are as familiar to him as his own door yard. He has traced out with patient care the great streak of hornblendic schist, with its wealth of minerals and its queer metamorphoses, from its entrance into our State near the Hoosac Tunnel, through Rowe and Hawley, Cummington, Chesterfield and Chester, forming here a soapstone quarry and there some outcrop of rare minerals, and every phase of the great band of rock is familiar to him. Foot by foot he has traced the devious ways of the geological formations, having performed this service for nearly half our State. The creditable record is one evidence of the excellent work that is being quietly done in the quiet town of Amherst.—Boston Commonwealth.

THE DIAMOND MINE OF AGUA SUJA, BRAZIL.

THE city of Bagagem, situated to the north of Uberaba, in Brazil, is celebrated through the discovery that was made there, in a diamondiferous deposit, of the large diamond known as the Estrella do Sul (Star of the South). This deposit is now exhausted, and has been entirely abandoned by the "garim peiros" (diamond seekers). But, at twelve miles from this mine, is situated the little village of Agua Suja, where the exploitation of a great mass of pebbles that covers the lower new red sandstone has been very productive in diamonds since 1867. This new mine, which is now in full exploitation, offers some very interesting peculiarities, and Dr. Eugene Hussak, who was formerly the geologist of the exploring commission of the central plateau of Brazil, has had an opportunity of visiting and very carefully studying it. The Brazilian geologist has just published the result of his observations in the report upon the recent exploration made by Mr. Cruls, the chief of the commission. We shall give a resume of this, embracing some interesting facts.

The geological structure of the great district of Brazil lying between Uberaba and the Rio Paranahyba is relatively simple. The small watercourses that have denuded this plain offer excellent sections for the study of it. As a base for the ferruginous sandstone that forms those fields, there is found a mica schist, rich in mica of a gray color, when it is not altered, or reddish when it is decomposed. This schist contains innumerable lenticels of compact quartz and veins of quartz rich in tourmalines.

FINAL SEPARATION OF THE DIAMONDS AT THE MINES OF AGUA SUJA, BRAZIL.

The ground is almost everywhere covered with pebbles, sometimes water-worn, sometimes detached, and sometimes cemented by limonite or quartz. The same geological structure is found at Agua Suja, where the stream of this name flows over the upturned edges of the strata of mica schists. It is in the fine sand of this stream that the diamonds are found.

When I visited the mine, says Dr. Hussak, I ascertained that the following minerals were being found, mixed with the diamonds, which are almost exclusively of the first water, but, unfortunately, relatively small: Staurolith, rutile, tourmaline, dodecahedral garnets with inclusion of quartz granules, sandstone pebbles, and fragments of micaceous schist.

Besides the diamonds, there are also collected in the vicinity of Agua Suja an abundance of beautiful cubical crystals of garnet without any inclusion. Finally, it is necessary to mention, among the pebbles of this locality, although as quite a rare element and a scarcely observable one in the very fine sands, small white and somewhat water-worn crystals of zircon. A single crystal of ruby was found by Dr. Luiz Gonzaga de Campos.

The conditions of the working by means of water are favorable at Agua Suja. Dr. Arena, who is the owner of the mine, is utilizing a beautiful cascade in the vicinity of his installation, that permits him to effect the exploitation by the Californian method. He employs a hydraulic jet of the Hopkins system.

The accompanying engraving reproduces a photograph representing the operation of the final separating of the diamonds.—La Nature.

RECENT EXCAVATIONS AT THE PYRAMIDS OF DAHSHUR.

FEW sources have supplied more facts for the study of anthropology than the Egyptian tombs, and the most important necropolis of Egypt is situated southeast of Cairo, close to the remains of ancient Memphis. This stretches from the village of Abou-Roash on the north to that of Medum on the south, about a distance of twenty-five miles.

To the south, and at the end of the great chain of pyramids, are those of Dahshur, of which four are of stone and two of brick. Up till 1892 the history of two of these still remained to be unraveled, but in that year a large party of excavators, headed by M. De Morgan, set out and succeeded in opening up both these pyramids. It is to this interesting work we wish to draw attention, for it marks an important step in Egyptology, indicating some of the earliest applications of science in one direction known to us, while ancient art is at the same time illustrated. M. De Morgan has recently given an account of his explorations in Le Monde Moderne.

The two pyramids are of brick, and covered with a layer of limestone; each one was surounded by a brick wall, which showed the limits of land reserved for the use of the royal family. Round this was an avenue, left out of respect to the descendants of the gods; then came the tombs of the great people connected with the court. From inscriptions found, there is every reason to believe that these two pyramids belonged to Usertsen III and Amen-em-hat III, both of the Twelfth Dynasty. On the north side of the more northerly one are the tombs of some princesses, four among them more important than the rest.

These tombs have been plundered, for, owing to the Egyptian custom of burying jewels with their dead, the pyramids have ever been a favorite resort of robbers; and thus it is that some of the tombs are in great disorder, which causes much hindrance to the scientific research now being carried on, more especially as many documents have been carried away. Still, the plunderers have not stripped them entirely, and the remaining documents and treasures have been a most important clew to finding out the dates of the pyramids and the history of the people they entomb.

This spoliation of the tombs, continued by each successive generation, was not stopped till the celebrated Mariette founded the "Service for the Conservation of Monuments in Egypt."

Among the most interesting and perfect pieces of jewelry found are three pectorals. They were found in the princesses' tomb and had been hidden in the soil in order, no doubt, to deceive the plunderers.

The first one unearthed has in the center the cartouch of Usertsen II, held by two hawks, which bear the crown of lower and upper Egypt. The signs of the cartouch are made of carnelian, lapis-lazuli and turquois, set in gold; the other figures are likewise set with precious stones. The other two pectorals are similarly executed. The first represents two men, each in the act of striking with a club an Asiatic captive whom they are holding by the hair. In the center is the double cartouch of the king, and on each side the emblem of life, out of which protrude two arms holding a flabellum. Above them all is an eagle with outspread wings, having in its claws the symbols of eternal life and stability. The second one has similarly an eagle with outspread wings, and beneath it is the cartouch of Usertsen III. To the right and left is a sphinx with the head of a hawk, on which are the feathers of Ammon: each is standing on a captive, while in front of each kneels an interceding Asiatic prisoner.

The workmanship of these jewels is wonderful. The perfection with which the precious stones are set, and, moreover, the delicacy and freshness of the whole, makes it hard to believe them five thousand years old. The work shows how far science dates back, and is evidence that in the case of the Egyptians the further we look back, the higher we find their culture.

It is a curious fact that when we compare these jewels with those of a later period, we should find them far superior in workmanship; but so it is, for those of the time of the Ramessids are but an imperfect edition of the more ancient ones, not nearly so artistic nor yet so well finished off.

When the excavations were continued, five large barges were brought to light; it was not till the work had continued some time that the royal apartments were found, so cleverly were they hidden.

The pyramid of the south is the most southerly royal monument of the Memphite necropolis. Traces are still to be found of a wall round it, and similarly situated as the princesses' tombs at the pyramid of the

north; here, too, we find a gallery of twelve vaults or tombs, of which only two contain mummies, one being King Ra-Fou-Ab and the other a princess, Queen Noub-Hotep.

Near the king's sarcophagus is a small chamber, in which were a quantity of broken vases and chests, and in a great wooden tabernacle was a statue of the double of the deceased, painted gray, representing a young man of fifteen or sixteen. It is made of hard wood, almost black, and is admirably done; every muscle and vein are perfectly placed, and specialists have certified its veracity. It is a fine piece of Egyptian sculpture, of which only four good specimens have descended to us. Some savants have endeavored to classify what has been found into certain schools, but this is scarcely advantageous till more has been collected.

The well leading to the princesses' tomb is about 13 feet deep. At the bottom is a vaulted brick passage, which formerly ended in a wall. As was suspected, the wall being removed revealed a vault containing a flagstone, on which were water jars, pieces of embalmed meat and other offerings, also two cases containing many things pertaining to the toilet. No inscriptions were found until the flagstone was removed and a coffin brought to light, on which were many texts relating to the name and title of the princess. As this tomb is so similar to that of King Ra-Fou-Ab, and is so closely situated, it is supposed that the princess was his wife; but nothing has been found to confirm her marriage with him.

Although a great deal has been done, it will require many years of hard work to open up all the tombs in the Dahshur necropolis; but general interest has now been awakened, thanks to those who have been the means of making us acquainted with the preceding facts; the results of future action will be followed by many.—Nature.

[FROM KNOWLEDGE.]

THE COINAGE OF THE GREEKS.

By G. F. HILL, M.A.

BY a coin is usually understood a piece of precious metal (as a rule gold, silver, or copper) of a size and shape convenient for handling, and marked with some stamp to guarantee its genuineness and save the trouble of continually calculating its value. In the days before the invention of money, exchange had been carried on by a process of barter, so much of an article offered being exchanged against so much of an article required. But it was naturally found convenient to agree upon a medium having some intrinsic value, and not liable to excessive fluctuations, which would always be desirable, and would, therefore, be accepted at all times by all parties. As early as the seventh century before Christ in Asia Minor, and, perhaps, even earlier in the far East, it was found that the most practicable medium was a precious metal divisible into small quantities, each of which would be equivalent in worth to comparatively large quantities of other articles of commerce. In earlier times we find various other things, more or less clumsy, employed as measures of value. For instance, over a great part of the world, the unit in terms of which other articles were valued was the ox. A less bulky unit is the cowry shell, used even at the present day in some parts of Africa, where the employment of metal for this purpose is impossible or has not been thought of. The traces of such customs long remained, being, perhaps, most marked in the conservative Chinese Empire, where pieces of metal in the shape of small knives or spades long continued to circulate, or in Burma, where coins are still cast in imitation of shells.

Coinage, then, properly speaking, begins with the use of small pellets or lumps of metal of fixed weight; and that these may be plainly stamped, they have to be of a somewhat flattened form. This is the shape of the earliest coins of Greece or Asia Minor which have come down to us. The blank of metal, being placed (often in a heated state) on an anvil, was struck with a stamp. A design let into the anvil left its impression on the lower side of the blank (generally called the obverse), while the upper (or reverse) side was marked by the stamp. The latter instrument was at first left undecorated (Fig. 1), but was afterward elaborated until the reverse design became nearly as important as the obverse. The ancients seem to have always used bronze for their dies, and as this soft material easily wore out, the dies had constantly to be recut. The result was an enormous variety in design, and it is rare to find two ancient coins from the same die. Neither did they use a collar to confine the metal, which, consequently, was liable to spread irregularly in the striking, sometimes to splitting point. And the fact that the striking was done by hand accounts for the frequent occurrence of what are called double-struck coins, when the second blow brought the stamp down in a different place from the first, or the coin had shifted between whiles on the anvil.

The fabric of Greek coins went through a steady process of development. The earliest blanks were of a somewhat dumpy, oval shape—in fact, resembling a bean in form. But by the beginning of the fifth century a flatter and rounder shape had become almost universal. The impression made by the stamp, the head of which was square or oblong, or a combination of two or more of these shapes (see Fig. 1), now sank deep into the blank, and a raised border was thus left round the design. With time the depth of the incuse decreased, and toward the end of the fifth century we find the incuse square often replaced by an incuse circle, or entirely disappearing. After about 390 B. C. it may be said to be almost entirely absent, save when, for some reason, a few cities revived it on their issues at a much later period. The stamp, however, which was now generally circular, naturally continued to produce a more or less concave field on the reverse of the piece. In the third and second centuries the flattening and spreading of the coins was carried still further, but never so far as to destroy the strength and solidity of fabric which makes a coin satisfactory to handle. The bronze coinage which begins in the fourth century is, like the silver of earlier times, thick and dumpy at first, but soon yields to the general tendency and becomes flat and spread.

It is curious that the material used by the people to whom the invention of money is attributed—the Lydians, a wealthy and powerful race of Asia Minor—is neither gold nor silver, but a mixture of the two. This mixture, which is called electrum, was found in a natural state in the district inhabited by them, and its adoption is therefore easily understood. Its value in relation to silver was supposed to be about ten to one, while the proportional value of gold to silver was in the less convenient ratio of $13\frac{1}{3}:1$. As a matter of fact, modern analysis has proved that the amount of gold in electrum coins varies very considerably; but a rough proportion was probably sufficient for the times. Electrum, however, was not found everywhere, and in the sixth century gold and silver came into use—a change associated with the proverbial name of Crœsus the Lydian. The Greek cities of the Asiatic coast and in Europe readily adopted the invention of the Lydians, but the scarcity of gold in Europe almost entirely limited the coinage of European Greece to silver. Thus, while some of the Greek cities of Asia Minor continued to coin electrum, silver was the metal employed in the other cities of that continent and in Europe. Gold was a monopoly of Persia until the end of the fifth century. Although the ancients understood the art of debasing and plating, the purity of their coinage in these early times is remarkable. As to the other metals, a very short notice must suffice. We hear of iron coins in Sparta, and tin coins at one period in Syracuse; but none of these have come down to us. Bronze was introduced in the fourth century, and remained the usual metal for the smaller denominations. The increasing wealth of the Greek cities now enabled them to issue gold, and Philip II of Macedon (359–336 B. C.) and his son, Alexander the Great (336–323 B. C.), struck enormous quantities of gold as well as silver coins. One other metal, it is interesting to note, was used in the second century by a few of the kings of the remote district of Bactria (corresponding to southwestern Turkestan), to which the ambition of Alexander had carried the arms and civilization of Greece. This was an alloy of copper and nickel, in almost the same proportions as are employed by several modern states. The discovery of "kupfer nickel" in the eighteenth century was thus anticipated by some two thousand years.

The unit of coinage was called the stater. As different cities coined on different standards, this varied considerably in weight. The question of standards, far from settled as it is, cannot be discussed here. It must suffice to mention, with regard to denominations, that the stater was divided into two (exceptionally three) drachms, and the drachm into six obols. Larger denominations were the di-stater or tetradrachm, the octadrachm, and the decadrachm, of four, eight, and ten drachms respectively.

Tradition attributes the first striking of coins in Greece proper to Pheidon, King of Argos; but what he actually did in this direction is a subject of much dispute. We may, however, be certain that coinage was first adopted in Greece about the end of the seventh century. From Greece proper, with the colonization of Italy and Sicily, the art of coinage spread to the western Mediterranean in the middle of the sixth century. The earliest Italian coinage is of a peculiar fabric, the reverse design being the same, or nearly the same, as the obverse, but represented in intaglio (incuse) instead of in relief (Figs. 3 and 4). In Sicily no such peculiarity is found.

The fifty century witnessed the transition from archaism to artistic perfection, from the stage in which the artist produced a sometimes grotesque but always honest attempt to represent his object to that in which he obtained perfect mastery over his material and tools. Owing to the disappearance of the incuse square or circle, both sides of the coin became flat, and the design on both stood out nearly equally in high relief—a relief much too high from the modern point of view, according to which coins should be flat and easily packed together. But to the height of the relief is due much of the effect of ancient coins, which present us, in fact, with a sculptured design, not a flat outlined pattern.

ANCIENT GREEK COINS.

Although most states obeyed the general tendency, and produced better executed work as time went on and skill increased, it is noticeable that some of the greatest commercial cities adhered to certain archaisms of style or fabric, probably because the scope of their commercial relations forbade any innovations which might damage the genuine appearance of their money in the eyes of the less civilized peoples with whom they traded. Thus the coins of Athens (Fig. 6), the chief center of Greek art, are rude to excess in comparison with the contemporary productions of other cities (Fig. 12). And the important city of Cyzicus, on the present Sea of Marmora, continued down to the middle of the fourth century to put no design on the reverses of its numerous electrum staters, the obverses of which were, nevertheless, executed in the best style (Fig. 14).

By the fourth century, the art of coinage had reached

its highest point. Nothing is more generally admired than the famous "medallions" of Syracuse, struck in the late fifth and early fourth centuries. These large decadrachms, of which we give an example (Fig. 8), are perhaps the most showy pieces of antiquity—indeed, it is doubtful whether they circulated as ordinary coins, and were not rather show pieces, or money struck for prizes. The chariot and four, and the prize set of arms—helmet, cuirass, shield, and greaves—represented in the exergue, seem to bear out this latter opinion. The games to which the type obviously refers may have been those instituted by the Syracusans in the flush of their victory over the Athenians on the Assinaros in B. C. 413. The main design, however, had been anticipated more than sixty years before, on a coin to which we shall have to refer on a later occasion. Many of these medallions bear the names of the artists who designed them—Kimon and Euainetos—names which would otherwise have been totally forgotten, though their work takes an easy place in the first rank. Fine as these coins of Syracuse are, they are still only typical of a great number of equally beautiful pieces struck, not only in Sicily and South Italy (Figs. 9 and 10), but in widely distant places such as Elis (Fig. 12) and Amphipolis in Macedonia (Fig. 13).

The coins of the best period are successful because they combine nobleness and simplicity of conception with perfect execution. But from this time onward the latter quality becomes ascendant, and as skill of hand is powerless to produce good work unless the mind supplies good ideas, toward the end of the fourth century the decline of art in coins, as in all else, has thoroughly set in. The influence of Philip and Alexander of Macedon was decisive, not only in politics, but in all forms of human activity; and the personal element which they introduced became dominant in art. The designs of coins had hitherto, as a rule, been connected with subjects relating to the state as a whole, its religion, its athletics or its commerce; the successors of Alexander used the royal prerogative of coinage to commemorate themselves and their own interests. Hence the beginning of portraiture. Philip and Alexander themselves had adhered to religious or athletic types (Figs. 15–18); but the head of Heracles on the latter's coins (Fig. 18) was only an idealized representation of Alexander conceived as Heracles. And his successors, going a step further, put the portraits, first of Alexander, with some divine attribute (Fig. 19), and then of themselves with similar attributes (Fig. 20) or as human rulers, where formerly only the gods, or at least impersonal subjects of state importance, had been seen. The name of the ruler, with the epithet "king," also replaced the name of the people, and the place of mintage was indicated, if at all, only by a small symbol or initial letters in the field of the coin. The imagination which characterized the earlier designs is replaced by a realism which, it is true, produces most marvelous representations of individual men, but which is, nevertheless, equaled by the art of other countries, while the art of Greek coinage in the preceding period stands unapproached. Some of the most striking of these portraits were, strange to say, produced in the distant land of Bactria, to which we have already referred (Fig. 22).

But the vast mass of Greek coinage from the third century ceases to possess an interest anywhere approaching that of earlier days. The types become formalized and stereotyped. The great issues of Philip and Alexander (from the gold coins of the former our own early British coins were by a slow process of degeneration developed) remained for some time the chief currency of the ancient world. Next to them for importance rank the issues of Lysimachus, King of Thrace, of Athens and Rhodes, and of the Kings of Syria, Pergamus and Egypt. But all alike are less interesting to the artist than to the minute historian who studies the sequence of rulers and monetary magistrates.

The work is usually poor and hastily executed; in fact, the pieces have almost ceased to be works of art, and are mechanically reproduced. In time the influence of Rome begins to be felt, to the destruction of whatever artistic purpose lingers still. The Roman rulers struck coins (Fig. 21) in the Asiatic provinces, which bore, it is true, a type relating to a religious subject (the cista or chest connected with the mystic worship of the wine god Dionysos, from which the coins were called cistophori), but the coins were no longer closely associated with the life of a particular city which issued them. It was the lively interest of the Greek in the affairs of his own city which had enabled him to produce the finest art. In the universal empire of Rome the individual Greek could have no part, and the intellectual, as well as the political, center of the world was now shifted to the banks of the Tiber.

In this brief sketch of the coinage of Greece we have dwelt mainly on the external form which that coinage assumed. There is one question, however, which we must not be content to pass over with a mere allusion, and that is the actual significance of the types before the period in which, as we have seen, the influence of the ruler became supreme. Before the introduction of money, types bearing some resemblance to those afterward found on coins occur on the engraved gems which were used to set the seal of ownership on articles of value. Now the state, in issuing coinage, would wish to mark it with some stamp representative of itself and its right to make such issues; and as the Greeks were an essentially religious people, it was natural that they should regard the chief deity of a city as its representative. Hence it is that a very large proportion of coin types have a religious significance. The human figure or face is, however, the last thing in the delineation of which art attains mastery, and consequently the early artists were content to represent god or goddess by some symbol or attribute, rather than in person. A stag represents the huntress Artemis; a thunderbolt Zeus, the god of the sky; a lyre or a tripod (Fig. 3) Apollo, the god of music and prophecy. But this is far from exhausting the nature of coin types.

Those natural objects which were especially characteristic of a place and its surroundings would, of course, suggest themselves; a maritime city, whose chief interest was fishing or seafaring, would engrave on its money perhaps a ship, perhaps a dolphin, a sea shell, or a cuttle fish. Lions, goats or boars (Fig. 5) would figure where these animals were plentiful. The wild celery grows in such large quantities near Selinus, in Sicily, as to give its name to the town, and its leaf figures on the coins, just as does the fig leaf on the coins of Camirus, in Rhodes. The particular article of commerce for which a city was famous might be suggested by its coin type; thus we find trade in wine represented by a wine jar or wine cup. Silphium (Ferula tingitana or, perhaps, Thapsia gummifera) was a plant much cultivated on the Barca plateau, and, therefore, was the almost constant type of the coins of this district of Northern Africa. Some coins of Barca bear the silphium plant with a gazelle couched before it or browsing on its shoots. On another (Fig. 11) the silphium is seen from above, and in the field are a jerboa, a chameleon, and an owl. Another little piece of local color is found at Metapontum, in South Italy, where on one coin the "praying mantis" (Mantis religiosa) is seen perched on a leaf beside the main type (an ear of corn, cp. Fig. 4). Much has been written to prove that all types are in their origin commercial, and that, for instance, the occurrence of a boar denotes a special line in hams. Neither this view, nor the view that all types have a religious significance, expresses the whole truth. The fact is, that a city famous for its wine would naturally regard the wine god as its chief deity, and, therefore, represent him, or something connected with him, on its medium of exchange. The proof of this is that as soon as the Greeks became able to represent the deity in question satisfactorily, the article of commerce over the production of which that deity presided occupied, as a rule, a subordinate position on the coins. Athens was famous for its olives, which were under the protection of Athena; and on the later coins the head of Athena occupies the obverse or more important side, while the reverse bears the owl (symbolic of Athena's wisdom), the olive wreath, and the jar of olive oil (Fig. 23). A city situated on a river of importance often adopted as type the representation of the river god (conceived as a bull—significant of the stream's tumult and force—or a monster with the body of a bull and the head of a man, or again, a horned man). Still, many a coin type remains less than half explained. Why have we on the coins of Lampsacus in Mysia a combination of two heads, looking different ways, on a single neck? Why a cock on the coins of Himera, in Sicily? It may be connected with Asclepios, the physician god, for there were healing springs in the neighborhood; or, though this is less probable, the "bird of day" may be a punning allusion to the city name, which only differs slightly from the Greek word for day (hemera). The use of punning types was by no means uncommon. Thus, on coins of Phocæa, in Asia Minor, we have (Fig. 2) the seal (phoke); on coins of Rhodes, a rose (rhodon). Other types, again, allude to some event connected with the history of a city; thus, on some coins of Thebes, an infant Heracles, strangling the snakes which attacked him in his cradle, symbolizes the struggle with the old established power of Sparta, in which Thebes (where Heracles was worshiped) was victorious. Or the victory won at the Olympian games by the ruler of some Sicilian town would be commemorated by a chariot drawn by horses, on the heads of which, or on the head of the charioteer who guides them, the goddess of Victory places a wreath. One of the most remarkable of Greek coins (Fig. 7) was struck just after, and may allude to the great victory of the Greeks over the Carthaginians at Himera in the same year (480 B. C.) in which the Persians were defeated at Salamis. On the reverse is a female head (perhaps that of the goddess of Victory herself) wreathed with laurel, and surrounded by the name of the people (the Syracusans). Around swim four dolphins, expressing, with a symbolism characteristic of the time, the fact that the sea surrounds the island of Ortygia, which is the center of Syracuse, and which the goddess represented has under her protection.

But the discussion of the types of Greek coins might be prolonged indefinitely. For further information on this and the other matters with which we have dealt so slightly, but it is hoped suggestively, the student must be referred to books like Head's "Historia Numorum" and Gardner's "Types of Greek Coins," illustrated works which cover in a scientific way the vast field of Greek numismatics. The subject is one in which the student of the history of the ancients, their politics, commerce, art and religion, should be thoroughly grounded before he can pretend to understand the facts, often distorted by literary tradition, about the life of a people from whom we have not a little to learn, and who, at least, will always remain interesting for their own sake.

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2. Phocæa. Electrum. About 600 B. C. Seal.
3. Croton. About 500 B. C. Tripod.
4. Metapontum, " Ear of corn.
5. Methymna. Early fifth century. Boar.
6. Athens. Tetradrachm. Late fifth century. Obv., Head of Athena. Rev., Owl and olive spray.
7. Syracuse. Decadrachm. 480 B. C. Obv., Female head surrounded by dolphins. Rev., Victorious four horse chariot.
8. Syracuse. Decadrachm by Euainetos. Early fourth century. Obv., Head of Persephone surrounded by dolphins. Rev., Victorious four horse chariot.
9. Terina. About 400 B. C. Head of Victory.
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15. Philip II of Macedon. Gold. Obv., Head of Apollo. Rev., Two horse chariot.
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17. Philip. Tetradrachm. Obv., Head of Zeus. Rev., Race horse.
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19. Lysimachus, King of Thrace (323-281 B. C.) Tetradrachm. Obv., Head of Alexander with horn of Ammon. Rev., Athena.
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ONCE every year the Emperor of China, amid great pomp and ceremony, plows a furrow in order to dignify agriculture in the eyes of his people.

THE ROMAN TOWN AT SILCHESTER.

THE systematic excavation of the site of the large Roman town at Silchester, under the auspices of the Society of Antiquaries, was resumed, for the sixth year in succession, at the beginning of May, the scene of operations being a hitherto unexplored insula, or square, lying midway between the basilica and west gate. This insula has been found to be almost entirely covered with the foundations of two very large houses, each of which had a courtyard facing north and entered from the main street on that side by a gateway of considerable importance. The easternmost house has a street frontage of more than 200 ft. and extends backward for over 150 ft. Its principal chambers were on the west side and had mosaic floors, unhappily almost entirely destroyed. A vestibule in the north part of the house, about 12 ft. wide and 50 ft. long, has fortunately nearly the whole of a very remarkable mosaic pavement. It consists of a groundwork of common red and drab mosaic, arranged in long bands or panels, filled with squares or lozenges, and coupled by frets. In this are set, in somewhat capricious fashion, no fewer than five, if not six, panels of fine mosaic work of excellent design. First, there are two small squares, each 2 ft. across, placed side by side with an interval of a few inches. Then comes a large panel, 6 ft. square with a bust (unfortunately much injured), within a circular border. Beyond this is a long and narrow panel of interlacing work, and beyond this again the remains of a fine panel (or, perhaps, two placed end to end) over 20 ft. long, which has evidently been almost entirely destroyed within the first few years by a "scarifier." Very few instances of so elaborate a combination of coarse and fine mosaic patterns have come to light in Britain. At the west end of the vestibule is a small room on a lower level, with a very perfect floor of drab mosaic with a central panel of fine work, but this is injured in the center. Against its east wall are the remains of a fireplace, a most uncommon feature in Romano-British houses.

The other house is quite as extensive as the first. Its plan resembles that of most of the large houses found at Silchester, and of the principal Roman villas in this country, a series of chambers lined by corridors and arranged round three sides of a courtyard. Only the principal wing, that on the east, has as yet been completely uncovered, but in this, besides two rooms, warmed by hypocausts, are no fewer than five other rooms, all of considerable size and with mosaic floors. The northernmost room has in the center a large panel of fine mosaic, about 15 ft. square, composed of five large circles within octagons, and filled with stars and geometrical figures, the whole being inclosed by a broad border of braid work and set in a ground of red tesseræ. The colors used are black, white, red and yellow. About three-fourths of this pavement is intact. The next room has an almost perfect mosaic pavement composed entirely of fine black and white tesseræ arranged in 81 squares or panels of geometrical design coupled by fretwork. It measures about 14 ft. by 16 ft. and is set in a ground of coarse red tesseræ. The next room had a fine mosaic pavement of about the same size as that just described, composed of 16 octagonal panels of black, white, red and yellow tesseræ, but unfortunately almost the whole is destroyed. A passage paved with ordinary red tesseræ separates the three northernmost chambers from the other two. One of these has a plain red pavement only. The southernmost chamber retains a nearly perfect mosaic center, about 14 ft. square, formed of nine hexagonal panels, with floral and other devices, all of good design and character. Whether any other fine mosaics will be found in the other parts of the house remains to be seen, as at present only the lines of the walls have been traced. It is hoped that it will be found practicable to remove the better preserved pavements to the Reading Museum, where the Silchester Loan Collection has been deposited by the Duke of Wellington.—London Times.

NOTES ON HARDY PLANTS.

UMBILICUS SPINOSUS.—I wonder if it will be credited that this is really quite hardy—hardy to the extent implied by plants fully exposed all the winter of 1894-95? Generally, I believe, this neat and curious plant has been considered to need protection in even ordinary winters, and I have always made a point of placing it in a frame as soon as the fogs begin in October. I had, however, a good stock last year, and I purposely left out three specimens. All are now in good health, even one that was badly grazed by slugs in the autumn. If this succulent sometimes fails to stand our winters, it is not merely owing to the cold, for my plants must have several times had frost on them within two degrees of zero.

Aletris Farinosa.—In same or very similar conditions to the above as to aspect, a specimen of this has much surprised me by coming through the winter safely; it is at the base or moister part of the rockery, and not only is it not hurt, but it is now throwing up flower spikes. The plant is a two year acclimatized specimen.

Hypericum Balearicum.—I never could keep this even in mild winters. I was induced to try it repeatedly because I heard from garden friends how well it did and that it survived the cold; so on the chance that such a singular and beautiful species might be coaxed I often tried it, but it went off at the end of summer. A friend in Wales told me early last spring that his plants, though injured, were pretty safe. Many of us, however, have learnt to put little or no trust in the appearance of some plants until they have had the drying winds of March and the brilliant sunshine of April and May come over them.

Genista Andreana.—This shrub, as supplied by the trade, is pretty generally killed all over the country, at least so far as to be of no use for display this June. I raised some plants a few years ago from seed, and, as I explained last year in these columns, but a small percentage came true, i. e., yielding the partially crimson or mahogany colored flowers. The pan of seedlings in its entirety was planted, with the result that the common broom (G. scoparia), the Andreana, are flourishing and flowering now in a mixed mass. Now what I want to point to especially is the fact that this crimson form got from seed is of a hardier constitution beyond all doubt. There is not a blackened twig on it, and in the same garden the worked (grafted) specimens are useless, and many quite killed. I venture to suggest

that either the grafting or the Laburnum stock, which I believe is the one always employed, is not the best for scions of a variety thus proved to be otherwise more enduring.

Arenaria Huteri.—The pygmy herbage of this sandwort is so dense, compact and pubescent as to resemble that of Androsace Wulferi. I speak of its habit at the flowering time, and its flowers for the size of the other parts are quite large, resembling the full sized pips of a white lilac. It is of slow and dense growth, and during flowering the specimen is simply a flattened ball of snowy white bloom. It is quite cold and damp proof. My plant has been two winters in the open.

Spiræa Anthony Waterer.—This is a decided advance on S. Bumalda; even the as yet small plants prove the free flowering habit, as well as the deeper rosy crimson corymbs of blossom. I notice that in the case of every plant there is a tendency to variegation in the leaves—creamy white. One more question occurs to my mind about this spiræa. Fine as it is, I do not see much difference between it and a kind I have grown two years as Spiræa Bumalda ruberrima. Perhaps it will be more just to compare them when the Anthony Waterer kind grows into stronger bushes.

Sobolewskia Clavata.—This, to those who have not fully proved its capabilities, may need a special note—a note of warning, so to speak, in the way of advising a not too hasty judgment upon it. It is a crucifer, with round, thick clavate leaves. The flower spikes run up in slender form quite 2 feet. At first the little white flowers may seem disappointing; they are inferior to those of the common Arabis, but the plant goes on and on spreading and branching. There is a wonderful development of lateral florescence and the early flowers are long lasting; the consequence is, you get a cloud of pure flowers, elegantly posed on slender stems, which, seen at a short or long distance, is most effective. It is in this way only that I can see any value in this point for decoration. I should advise that it be planted in threes or sixes, though in time the roots, which run somewhat, will make a wide specimen; but it is time that means all with this species, for if not seen in a bold piece the first year, I fear many would pull it out. It certainly deserves a better fate, and judiciously placed, it will do capital service.

Edraianthus Serpyllifolius.—Never have I seen this lovely Alpine flower so profusely as last spring. Plants need to be three years old before they give a true idea of what they really are, yet flowers occur the first year from cuttings and seed. Tender care must be bestowed on young stock, as a slug may spoil half a dozen in one night.

Edraianthus Pumiliorum.—Charming as the above is, this to my mind is even more so, the flowers being larger and of a sheeny red-purple. The flowers are set off by the quite distinct foliage, which is grassy, all radical, and of a gray or glucose hue. The Edraianthi are supposed to be short-lived, but I think this is an error. The contrary is proved if you keep slugs away from them, but how to do it is the puzzle—they are so partial to these dainty things; and not only do they eat the tops in summer, but in mild periods in winter they will eat off the crowns right down below the surface. My plan is to dash over the plants once a week some dry silver sand; this is otherwise beneficial, as it repels the hot sunshine and helps to fix the slender collars.

Dianthus Michael Foster.—This is an early pink of the Alpine class. It is a sort of glorified D. alpinus, and suggests itself as something between alpinus and neglectus, and a better perennial than either. I have a strong specimen of this first now in full bloom, stature seven inches.

Saponaria Ocymoides Splendens.—If you want bright rosy, red color and plenty of it, plant this by all means; it is a glorious variety for bright weather, lasting a long time in the most exposed positions, but for effect at twilight the paler type is not to be despised; indeed in the evenings of the latter half of May and well into the month of June it actually lights up the rock garden by its myriad flowers and broad masses.

Primula Reidi.—This is now in bloom, and a plant to linger over. How rapidly the whole plant develops; there is scarcely a part of it to be seen in the last week of April, and by the first week in June or earlier in more salubrious climates than Yorkshire it gets into flower. The flowers are creamy white, with just a suspicion of blue milk white in the older flowers; the perfume, too, is as peculiar as it is full and spicy. I get seedlings to flower sometimes the first year, mostly the second, yet it is a capital perennial primrose.

Asperula Athoa (Boiss.)—This is one of a group that has not long been grown here. None of our native species can scarcely give any idea of its habit and stature. It flowers profusely at a height of 2 inches to 3 inches; the whorled foliage is dense, thick and woolly, and the clusters of rosy carmine flowers terminate every half procumbent stem. At the first glance a flowering specimen suggests an Androsace. I am assured of its hardiness, but hitherto I have kept it under glass in a cold frame with air always on.

Asperula Nitida (Sib. and Sm.)—This is a totally different species; the tufts of leaves are as dense as a Club moss, and of deep, shining green, as implied by the name, and the bright coral red flowers are in such compact clusters as to almost cover the foliar cushions; the total height when in flower is a little more than 1 inch. Wedged between stones in vegetable soil that keeps moist it does well, and the effect is exquisite.

Asperula Carpathica is a more lax plant, growing 3 inches to 4 inches high, somewhat resembling hirta in other respects; flower bright rose. I am sure this trio of Alpine Woodruffs will delight Alpine plant growers.

Iris Verna.—I have now tried this fully exposed several years, and find it quite hardy. Stature 3 inches, or 6 inches to 7 inches when in flower. It likes a semi-boggy soil, and so grown is an evergreen plant with me. Its flowers are large for so small a plant, appearing in April, May and June. They last but two or three days, are delicate in their colors and chaste to a degree. It is just the thing for the base of the rock garden with an east or west aspect.

Saxifraga Cotyledon.—I believe this is less common than its variety pyramidalis, or even the queen of Saxifrages, longifolia, but it is, I think, superior to either as a flowering plant. Compared with these, usually considered the two choicest for big and symmetrical panicles of white bloom, its plumes are larger, denser and more elegant, and the flowers being pure white (without spots) with longer and narrower petals, the effect is far more graceful. It only needs to be seen side by side with the better known favorites, and I think no one would dispute its superiority.—J. Wood, in the Garden.

HARDY BORDER PLANTS.

WE are frequently asked by readers for lists of hardy and other plants, and we therefore offer no excuse for printing the following list, which contains what we regard as the best of the true herbaceous plants. Our aim has been to make a selection of the most reliable hardy flowers adapted to the soils and situations of gardens generally. No one can desire less than ourselves to limit the variety of plants of this sort, but a great deal depends upon whether a successful beginning is made in this way, and the following is a choice selection of plants upon which growers can depend, and which can be successfully cultivated in most districts. It should be borne in mind that, restricted as this selection is, there are whole classes of important hardy plants not included in it—for example, hardy bulbs, Alpine and rock plants, and, lastly, biennial plants and plants which, like the carnation and some of the double rockets, require annual division or multiplication for successful culture.

Acanthus spinosa
Achillea Ptarmica fl.-pl.
The Pearl
Eupatorium
Millefolium rosea
mongolica
Aconitum Napellus
bicolor
japonicum autumnale
Adonis vernalis
Alstrœmeria aurantiaca
Anemone japonica
Honorine Jobert
Pulsatilla
patens
coronaria, many vars.
alpina
fulgens
Robinsoniana
sylvestris
Anthericum Liliastrum
Liliago major
Aquilegia vulgaris and vars.
chrysantha
californica alba
cærulea
glandulosa
Stuarti
Armeria cephalotes
grandiflora
Arnebia echioides
Aster Amellus
lævis
acris
linarifolius
Shorti
turbinellus
versicolor
horizontalis
Novi-Belgii vars.
Bocconia cordata
Brodiæa Howelli
Calochortus in var.
Caltha palustris and vars.
Campanula Van Houtti
nobilis and vars.
celtidifolia
glomerata
dahurica
urticæfolia fl.-pl. alba
carpatica and vars.
grandis
isophylla alba
persicifolia and vars.
Cardamine pratensis fl.-pl
Centaurea montana and vars.
Centranthus ruber and vars.
Cheiranthus
Chelone (hybrid vars.)
Chrysanthemum latifolium
maximum
indicum, good outdoor kinds
Cimicifuga racemosa
Coreopsis lanceolata
grandiflora
Coronilla varia
Corydalis nobilis
Cypripedium spectabile
Delphiniums in var,
Delphinium belladonna
Dielytra spectabilis
Digitalis (Foxgloves)
Dodecatheon Meadia and vars.
Doronicums in var.
Echinops Ritro
Epilobium Fleischeri
angustifolium
album
Epimedium macranthum
superbum
Eremurus robustus
Bungei
himalaicus
Erigeron speciosum
Eryngium alpinum
amethystinum
Olivierianum
giganteum
planum
Funkia Sieboldi
japonica
grandiflora
Gaillardias in var.
Galega officinalis and var. alba
Gentiana asclepiadea and alba
acaulis
Geranium armenum
sanguineum and vars.
Geum coccineum fl.-pl.
miniatum
Gypsophila paniculata
Helenium autumnale
pumilum
Helianthus decapetalus
lætiflorus
multiflorus fl.-pl.
rigidus var. Miss Mellish (Harpalium)
Helleborus niger and vars.
orientalis and vars.
colchicus
atro-rubens
Hemerocallis disticha fl.-pl.
[illegible]
[illegible]
graminea
Dumortieri
Heuchera sanguinea
Hieracium aurantiacum
Iberis sempervirens and vars.
Garrexiana
correæfolia
Inula glandulosa
Iris (rhizomatous kinds in var., especially Iris germanica and varieties Bridesmaid, dalmatica (pallida), Florentine, Gazelle, Madame Chereau, Queen of May, Victorine)
Kniphofia in var.
Lathyrus grandiflorus splendens
latifolius and white var.
Sibthorpi
Liatris spicata
pycnostachya
Linaria dalmatica
Peloria
Linum perenne and vars.
narbonnense
flavum
Lobelia cardinalis
Queen Victoria
Lupinus polyphyllus and vars.
Lychnis vespertina fl.-pl. alba
Viscaria rubra pl.
chalcedonica fl.-pl.
Haageana
Lythrum Salicaria splendens
Malva moschata alba
Meconopsis Wallichi
nepalensis
Megasea (Saxifraga)
Michauxia campanuloides
Monarda didyma
fistulosa and vars.
Œnothera missouriensis
fruticosa
speciosa
tanacetifolia
Youngi
Onosma tauricum
Orobus aurantius
cyaneus
lathyroides
varios
vernus and vars.
Papaver orientale and vars.
nudicaule vars., various
Pæonia anemonæflora and vars.
albiflora and many vars.
Pæonia officinalis and vars.
tenuifolia and fl.-pl.
Pentstemon procerus
barbatus Torreyi
Phlomis Herba-venti
Russelliana
Phlox ovata
canadensis
decussata
paniculata and vars.
divaricata
setacea and vars.
Physalis Alkekengi
Polemonium Richardsoni
cœruleum
reptans
Polygonum cuspidatum
Potentilla hybrida fl.-pl. vars.
Plumbago Larpentæ
Primula japonica
Sieboldi
Pyrethrum uliginosum
roseum and vars.
Rudbeckia Newmani
Ranunculus acris fl.-pl.
aconitifolius fl.-pl.
amplexicaulis
Saxifraga granulata fl.-pl.
(Megasea) ligulata and vars.
crassifolia
cordifolia and other vars.
longifolia
pyramidalis
Scabiosa caucasica
Scutellaria alpina and vars.
Sedum spectabile
Senecio pulcher
Sidalcea candida
Spiræa palmata
Aruncus (good vars.)
Filipendula fl.-pl.
japonica
venusta
Statice latifolia
Symphytum bohemicum
caucasicum
Tiarella cordifolia
Tradescantia virginica vars.
Trollius asiaticus
Fortunei
europæus and vars.
Veratrum nigrum
album
Verbascum phlomoides
Chaixi
olympicum
Verbena venosa
Veronica candida
corymbosa
longifolia subsessilis

—The Garden.

STANDING ROOM FOR A MILLION.—A vast number of persons can be placed in a small area. For example, a million of people standing together, each person occupying four square feet, could be got into a patch of ground little more than a mile square.

[FROM SCIENCE.]

NOTES ON THE PROGRESS OF ASTRONOMY DURING THE YEAR 1894.*

MINOR PLANETS.

TWENTY-THREE new planets were discovered. Permanent numbers have been assigned from 379 to 390, both inclusive. Eleven have, as yet, been unnumbered, as the investigations in regard to their orbits are not sufficiently complete.† The discoverers were as follows: Charlois at Nice 11, Courty at Bordeaux 2, Wilson at Northfield, Minn., 1, Wolf at Heidelberg 6, Bigourdan at Paris 1, Borelly at Marseilles 1, Roberts at Crowborough 1.

Minor planets are now picked up so rapidly by photography and other methods that, to avoid confusion in the numeration, Professor Kreuger, of Kiel, assigns a provisional rotation (A, B, C, etc., BA, BB, BC, etc.), arranged in order of their announcement to the 'Telegraphische Central-Stelle.' The final number is assigned by Professor Tietzen, director of the Rechen-Institut in Berlin. Numbers are assigned to those planets only for which sufficient observations are available for a determination of the orbits. Names are given by the discoverers.

Planet BE discovered November 1, 1894, by Wolf, is unique, having the smallest perihelion distance of all the minor planets, except possibly No. 323, Brucia, which was named after Miss Bruce, of New York City, on account of her generous contribution to astronomical work. The least distances of BE from the earth and Mars are about 63 and 21 millions of miles. It seems to be well adapted for determining Solar Parallax.

Professor E. E. Barnard measured, during the year, the diameters of Ceres, Pallas and Vesta with the great telescope of the Lick Observatory, and obtained the results as follows: Ceres, 520 miles; Pallas, 304 miles; Vesta, 241 miles. These planets are the largest of the family.

COMETS.

Five comets were discovered.

(a) Denning, of England, picked up the first on March 26, 1894.

Investigations seem to show that this comet makes a close approach to Jupiter (about 18,000,000 of miles). The orbits of Brorsen's and Denning's comets appear to intersect. Brorsen's comet passed the intersecting point February 7, 1881, and Denning's comet reached that point March 14, 1881. Perturbations may bring about a collision.

(b) On April 3, 1894, the second comet was found by Gale, of New South Wales. He used a telescope with object glass only three inches in diameter. The comet had a tail four degrees in length. Professor Barnard has studied this comet with unusual care and taken some exquisite photographs which reveal many details deserving most careful investigation.‡

Twenty lines were seen in the comet's spectrum. The orbit seems to be a parabola.

(c) By the aid of an ephemeris prepared by Schulhof this second return of Tempel's comet, first seen in 1873 and observed in 1878, was found by Finlay at the Cape of Good Hope on May 8. The error in the assigned place was only nine seconds of time in right ascension and thirty seconds of arc in declination. This discovery is a "recovery" of a comet after sixteen years.

The comet has a period of 5·2 years and is one of the fifteen periodic comets of which at least one return has been observed.

(d) Encke's comet belongs in the same class with the preceding comet and is one of the most interesting objects to the astronomers. It was originally discovered by Pons, of Marseilles, November 26, 1818. Professor Encke worked out its orbit and found it to be 3½ years, or 1,208 days, the shortest period of any known comet. It showed a continued acceleration in its motion to 1868, so that the time of each revolution about the sun was shortened by about 2½ hours. After 1868 the acceleration appeared to be diminished by one-half.

The cause of this peculiar acceleration was first thought to be due to a "resisting medium" in space or near the sun, but that theory is now abandoned and the idea is gaining ground that there is some undetected perturbation due to planetary attractions.

The thirty-third return of this comet was discovered independently by three observers, Perrotin at Nice, Wolf at Heidelberg and Cerulli at Teramo, on October 31 and November 1. All these astronomers were aided by the ephemeris calculated by Backlund.

(e) E. Swift, son of Lewis Swift, formerly of the Rochester Observatory, but now located in California at the Lowe Observatory, discovered on November 21 the last comet of the year 1894. There seem to be good reasons for believing this comet to be the "lost or mislaid" comet found by De Vico at Rome, August 22, 1844. It was expected to return in 1850, but "failed then and subsequently to keep its appointment."

SOLAR PARALLAX.

Dr. Arthur Auwers published Volume V on the German Heliometer Observations of the Transits of Venus, 1874 and 1882. In this volume the discussion of the observations is given. The final value of the solar parallax from the two transits is 8·896″ ± 0·0216″. This corresponds to a distance of ninety-one million miles. This value differs considerably from the value 8·81″ obtained by Harkness in 1891.§

MARS.

This planet was in better position for observation during the opposition of 1894 than that of 1892, although the planet was farther from the earth. Observers have noted that the south polar spot completely disappeared; that during the gibbous phase there were irregularities seen at the terminator which indicated mountains; that the canal system of Schiaparelli was generally confirmed, as well as the duplication of a number of the canals.

Excellent work was done by the observers at the

* Based mainly upon the Annual Report of the Royal Astronomical Society of London, February, 1895. Prepared at the request of the responsible editor.

† Numbers have since been assigned up to and including 404.

‡ See Astronomy and Astrophysics for June, 1894.

§ Solar Parallax and its Related Constants.

Lowell Observatory, Flagstaff, Arizona, in detecting additional canals and delicate details.

Some of the results of Mr. Lowell's expedition to Arizona have been published in the Astrophysical Journal for May, 1895.

Evidence has been obtained that at times vast areas are densely obscured by clouds. Several observers agree in noting that actual changes have taken place since 1877. Professor Campbell, of the Lick Observatory, made observations of the spectrum and has found no lines due to an atmosphere on the planet Mars.

This is in opposition to other evidence. Campbell's apparatus was more powerful than that used by the other observers.

JUPITER.

The new satellite of Jupiter is so small and its proximity to the parent planet is such that the satellite can be measured only in the largest telescopes.

Barnard was able to make at the Lick Observatory observations which make a good basis for a more accurate determination of the orbit. The periodic time is 11 hrs. 56 m. 22s. 0·618 ± 0·013s. The orbit is eccentric. Tisserand has shown that the major axis should make a complete revolution in about five months. Barnard prefers the name Satellite V.

Barnard sees on Satellite I dusky poles and a bright equatorial belt. These observations seem to explain the ellipsoidal and double appearances reported by other observers.

DOUBLE STARS.

The British Royal Astronomical Society presented in February, 1894, its Gold Medal to S. W. Burnham, formerly of the Lick Observatory, for his discoveries, measures and general work on double stars. In Volume II of the publications of the Lick Observatory is given a great proportion of Burnham's recent work.

At the Georgetown College Observatory experiments were made with a 12 inch refractor. Fifteen wide pairs were photographed. The results of the measures were not encouraging.

During the year Professor Glasenapp published his observations of 1220 measures on 610 pairs, made at Abastouman.

The orbits of ten double stars were computed and published during the year. The periods vary from 11·37 years, in the case of K Pegasi, to 208·1 years for η Cassiopeiæ.

NEBULÆ.

In Astronomy and Astrophysics for May Prof. Campbell, of the Lick Observatory, gave a table of bright lines photographed in the spectrum of the Orion nebula; of dark lines photographed in the spectra of the Orion stars, and of the comparison of bright nebular and dark star lines. He concludes that nearly all the dark lines in the faint stars are matched by bright lines in the nebula, but certain prominent nebular lines are not matched by dark stellar lines.

The stars appear to be closely related to the nebula in chemical constitution and may be physically connected.

Prof. Keeler, from his Observations at the Lick Observatory, drew the conclusion that the distance of the great Orion nebula from the sun is increasing at the rate of 11 miles per second. No relative motion of the different parts of the Orion nebula was detected. His investigations seem to show that nebulæ are moving through space with velocities similar to those of the stars.

POTSDAM PHOTOMETRY.

Drs. Muller and Kempf have completed, in its first stage, the investigation of the visual magnitudes of all stars recorded as fainter than 7·5 magnitude in Argelander's Durchmusterung, lying in the zones between north declination 0° to 20°. In a few years they hope to complete the investigation to the North Pole.

This research is the most accurate and complete of modern researches in the direction of photometric study of stellar magnitudes.

ASTROPHOTOGRAPHIC CHART.

Seven of the associated observatories have taken more than one-half the required catalogue plates. All these plates will be taken in two or three years.

The measurement of the catalogue plates was begun at the Paris Observatory.

The chart plates will not be completed probably until 1900.

ASTRONOMICAL PHOTOGRAPHY.

In Volume III of the Lick Observatory publications are reproduced several fine enlargements of lunar photographs taken with the 36 inch refractor cut down to eight inches. These enlargements were made by Dr. L. Weinek, of the Prague Observatory. In addition Dr. Weinek has published some excellent enlargements of moon photographs taken by MM. Loewy and Puiseux at Paris.

In February, 1895, the Royal Astronomical Society presented its gold medal to Dr. Isaac Roberts for his photographs of star clusters and nebulæ published in 1894. These superb photographs were taken with silver-on-glass reflector of 20 inch aperture and about 100 inches focal length. Professor Barnard, of the Lick Observatory, exhibited at the R. A. S. an exquisite set of sixty positives, on glass, of stars and comets. The publication of these photographs is under consideration by the society. The council of the R. A. S. is also at work on a method for reproducing the fine photographs recently made and for making the reproductions permanent.

VARIATION OF LATITUDE.

Dr. Chandler showed that there are two terms in the variation of latitude—one term with a period of a year, the other with a period of 428·6 days. He suggested that the pole rotates, not in a circle, but in an ellipse with revolving line of apsides.

During the year there was published the results of observations made in various parts of the world, including Prof. Doolittle's work at Bethlehem, Pa., and Prof. Davidson's observations at San Francisco.

NEW OBSERVATORY.

Mr. Percival Lowell, of Boston, established an observatory at Flagstaff, Arizona, at an elevation of 7,300 feet above sea level. His principal instrument was formed by a combination of two telescopes with apertures of 18 and 12 inches. These telescopes were mounted like a twin instrument.

Mr. Lowell, Professor W. H. Pickering and Mr. Douglass have given most of their time to the study of Mars. Extensive reports have been made in Astronomy and Astrophysics. J. K. REES.

Columbia College.

RECRUDESCENCE OF THE ACTIVITY OF VESUVIUS.

VESUVIUS has passed through a phase of activity which is attracting much attention, especially now that new earthquakes are manifesting themselves in Italy. Whoever ascends to the summit of the mountain will be seized with a timorous admiration in the presence of the imposing spectacle that unfolds itself before his eyes, especially during the night, upon the summit of the mysterious mountain. The geologist will there find a rich mine of materials for the study of the manifestations of the internal activity of the globe in general, and of the mode of formation of cones in particular.

In fact, in the wake of the increase of activity of this volcano, noticed as far back as January, the old crater of 1891 is tending to fill up and make place for a new cone, which is slowly and regularly rising on the northwest edge of the old crater. At present, it exceeds the edges of the latter by about 50 or 60 feet. This new cone can be seen from Naples even.

Since the middle of 1893, the epoch at which the eruption mouth of Atrio del Cavallo, which opened in June, 1891, ceased to flow, the external activity of the volcano has been very feeble, although this arrest of the lateral discharge might have made a recrudescence of activity in the great cone foreseen.

In January, 1895, the column of lava had sensibly risen in the volcanic chimney in overflowing slightly upon the platform of the bottom of the crater. There was a lull of a few days, with a lowering of the column of lava, followed by another slight thrust, accompanied with great disengagements of steam. From this moment the tension of the steam caused the surface of the lava to rise and swell in projecting it to a great height.

The frequency of these explosions is very variable. At the time of our visit to the volcano, made during

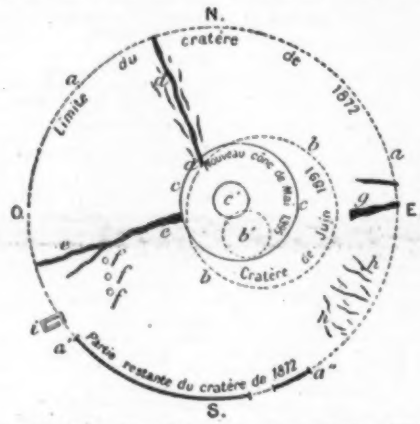

DIAGRAM SHOWING THE PRESENT STATE OF VESUVIUS.

a, limit of the edge of the crater of 1872. The part represented by the dotted line is at present covered by the lava that has overflowed at different times. The part a′ a″ is still bare. b, Crater of June, 1891; b′, active mouth of the crater of 1891; c, new cone now forming; c′, active mouth of the present cone; d, fissure and steam vent of June, 1891; e, fissure emitting acid vapors in the plain of the crater of 1872; f, very ancient hot air passages; g, fissure of May, 1889; h, numerous fissures upon the southeast edge of the cone; i, shelter of the guides.

the night of May 12, the great explosions occurred generally at an interval of a minute and a half. Certain of them projected the lava and scoria to a height of from 250 to 325 feet. During the period of relative rest other and less violent explosions occurred, but always accompanied with powerful puffs of steam.

Nothing could be compared to the imposing spectacle that the volcano presents as it projects into the air those jets of molten matter which afterward fall like the huge spangles of a gigantic piece of fireworks. Despite the great distance that separated us from the crater, we felt the heat of the projected lava.

During their passage through the air, the various materials thrown out by the volcano became cool, and, falling back upon the edges of the crater, built up the cone, or else fell back into the chimney to be thrown out anew. This is what constitutes the phase of formation of a cone. The new cone, which is quite irregular in form, had reached, on the 12th of May, a height of 228 feet above the bottom of the crater of 1891. It now exceeds the altitude of the portion of the crest of the crater of 1872, still existing to the east of the refuge of the guides. Its irregular form is due principally to the east wind that has prevailed during the last few months. Under the action of this wind the ashes have fallen in great abundance on the side toward Naples, and this has caused an enlargement of the cone toward the west.

Should the eruption continue with the same regularity, the new cone will gradually rise, in totally filling up the old crater. Admitting also a continuous thrust of lava, there would be nothing to prevent a lateral discharge upon the summit of the great cone, favored at this point by the rent of 1891, near which the new cone has formed.

The accompanying figure shows the changes that have occurred upon the summit of the mountain.—La Nature.

IT is not generally known, perhaps, because it may not be always credited, that pure, fresh cold water is one of the most valuable disinfectants, inasmuch as it is a powerful absorbent. Every sick room should have a large vessel of clear water, frequently renewed, placed near the bed, or even beneath it. This not only absorbs much of the hurtful vapor, but by its evaporation it softens and tempers the atmosphere, doing away with the dryness which is so trying and depressing to an invalid, or even to persons in health, for that matter. It has frequently been shown, by actual experiment, that troubled sleep and threatened insomnia are corrected by so simple a thing as the placing of an open bowl of water near the sufferer's bed.—Popular Science News.

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